NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

JOINT APPLIED PROJECT

Case Study:
The Application of ISO 9001:2000 to a Government Organization: A Study of the Benefits, Drawbacks and Effectiveness of ISO 9001:2000 for Navy Undersea Range Programs

---

By: **Andrew T. Appleget**
Wilfred M. Canto, Jr.
Larry W. Rothstein
September 2004

Advisors: **Michael W. Boudreau**
Raymond S. Munn

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** September 2004	**3. REPORT TYPE AND DATES COVERED** Joint Applied Project	
4. TITLE AND SUBTITLE: Case Study: The Application of ISO 9001:2000 to a Government Organization: A Study of the Benefits, Drawbacks and Effectiveness of ISO 9000:2000 for Navy Undersea Range Programs			**5. FUNDING NUMBERS**
6. AUTHOR(S) Andrew T. Appleget, Wilfred M. Canto Jr., Larry W. Rothstein			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES. The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			**12b. DISTRIBUTION CODE**

13. ABSTRACT ***(maximum 200 words)***

The Department of Defense has recognized the value of quality management programs for contractors since the establishment of the MIL-Q-9858 program in 1959. However, the application of quality management programs and principles within DoD has been accomplished with many and varied approaches, often Service and organization specific. Policy guidance on the use of quality management within DoD is limited to non-existent. ISO 9001:2000 has been successfully used by industry and is a recognized quality management system for the execution of DoD contracts, principally for production or manufacturing. This case study examines the application of the ISO 9001:2000 standard to a government organization conducting research, development, test, and evaluation for the U.S. Navy and assesses the benefits, drawbacks, and effectiveness of using ISO 9001:2000 within a DoD organization.

14. SUBJECT TERMS QMS, ISO 9001			**15. NUMBER OF PAGES** 115
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UL

NSN 7540-01-280-5500 (Rev. 2-89)

Standard Form 298 Prescribed by ANSI Std. 239-18-298-102

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

CASE STUDY: THE APPLICATION OF ISO 9001:2000 TO A GOVERNMENT ORGANIZATION: A STUDY OF THE BENEFITS, DRAWBACKS AND EFFECTIVENESS OF ISO 9000:2000 FOR NAVY UNDERSEA RANGE PROGRAM

Andrew T. Appleget
Wilfred M. Canto
Larry W. Rothstein
Civilian, United States Navy

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN PROGRAM MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 2004

Authors:

Andrew T. Appleget

Wilfred M. Canto

Larry W. Rothstein

Approved by:

Professor Michael W. Boudreau, Lead Advisor

Dr. Raymond S. Munn, Support Advisor

Douglas A. Brook
Dean, Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The Department of Defense has recognized the value of quality management programs for contractors since the establishment of the MIL-Q-9858 program in 1959. However, the application of quality management programs and principles within DoD has been accomplished with many and varied approaches, often service and organization specific. Policy guidance on the use of quality management within DoD is limited to non-existent. ISO 9001:2000 has been successfully used by industry and is a recognized quality management system for the execution of DoD contracts, principally for production or manufacturing. This case study examines the application of the ISO 9001:2000 standard to a government organization conducting research, development, test and evaluation for the U.S. Navy and assesses the benefits, drawbacks and effectiveness of using ISO 9001:2000 within a DoD organization.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS & ABBREVIATIONS

ADAS	Aberdeen Data Acquisition System
AMSWR	AUTEC Minefield and Shallow Water Range
ATC	Aberdeen Test Center
AUTEC	Atlantic Undersea Test and Evaluation Center
BRAC	Base Realignment and Closure
CAO/IPT	Competency Aligned Organization/Integrated Product Team
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
CNO	Chief of Naval Operations
COMLANTFLT	Commander, US Atlantic Fleet
DAWIA	Defense Acquisition Workforce Improvement Act
DFARS	Defense Federal Acquisition Regulation Supplement
DOT&E	Director of Operational Test and Evaluation
DoD	Department of Defense
DPR	Defense Performance Review
DSP	Digital Signal Processing
EIA	Electronics Industries Alliance
ISSA	Interservice Support Agreements
PM-ITTS	Program Manager for Instrumentation, Targets and Threat Simulators
KPP	Key Performance Parameters
LSVTC	Land-Sea Vulnerability Test Complex
MBO	Management by Objectives
MDAP	Major Defense Acquisition Program
MEO	Most Efficient Organization
MR	Code 70 ISO Management Representative
MRTFB	Major Range Test Facility Base
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NPD	NASA Policy Directive

LIST OF ACRONYMS & ABBREVIATIONS

NRO	Navy Range Office
NSFS	Naval Surface Fire Support
NSWC	Naval Surface Warfare Center
NUWC	Naval Undersea Warfare Center
NUWCDIVNPT	Naval Undersea Warfare Center, Division Newport
NWCF	Navy Working Capital Fund
QASP	Quality Assurance Surveillance Plan
QMS	Quality Management System
RDT&E	Research, Development, Test and Evaluation
RSDBU	Range Systems Development Business Unit
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SEI	Software Engineering Institute
TDA	Technical Direction Agent
TQL	Total Quality Leadership
TQM	Total Quality Management
USW	Undersea Warfare

I. INTRODUCTION

A. PURPOSE

The series of standards developed and maintained by the International Organization for Standardization (or ISO – from the Greek *isos* meaning "equal)[1] offer a collection of internationally recognized standards as tools for the improvement of organizational performance. While the majority of ISO standards are focused on a specific material, product or process, the ISO 9000 series is represented as a "generic standard" in that "the same standards can be applied to any organization, large or small, whatever its product - including whether its "product" is actually a service - in any sector of activity, and whether it is a business enterprise, a public administration, or a government department."[2] Within the United States Department of Defense acquisition community, the benefits of quality management standards have been recognized since the establishment of the MIL-Q-9858 quality management program in 1959.[3] With the transition of military acquisition to commercial standards begun by Secretary of Defense Perry in 1994, the government expanded the horizons of defense acquisition by recognizing the equivalence of commercial quality management standards, including ISO 9000, for application to products and services provided by defense contractors.

While quality management standards and programs have long been applied to contractors supplying DoD, there is no definitive guidance on the use of quality management standards *within* DoD. The Defense Department maintains a large collection of research and development organizations that specialize in fields and disciplines critical to national defense as well as organizations with numerous other functions. Those organizations primarily specializing in research and development focus on the specialized needs of the military where there is insufficient capacity in industry or the technologies are too

---

1 International Organization for Standardization, "About ISO Introduction," http://www.iso.ch/iso/en/aboutiso/introduction/index.html, Website modified 16 February 2004, Accessed April 20, 2004.

2 Ibid.

3 Hollis G. Bray, Jr., "ISO 9000 in Construction," Journal of Construction Education, Vol. 2, No. 3, Fall 1997, http://ascjournals.org/jce/journal/1997/no3/Fall%201997,%20Vol.%202,%20No.%203,%20pp.%20182-192.pdf, Accessed April 20, 2004.

specialized or sensitive for application to the commercial sector. Ultimately, the output of these organizations is translated into equipment, systems and services that are provided to the military to enable the execution of their assigned missions.

This case study will examine the benefits and drawbacks of the application of an ISO 9000 quality management system within one such DoD activity and draw comparisons with other applications of the ISO 9001:2000 standard within both industry and other government activities. It will also address the efficacy of the ISO 9001:2000 standard in an environment with diverse customers and programs with very low (often one) unit production. The primary focus of this investigation will be to determine if the application of ISO 9000 to a DoD laboratory improves efficiency, value and quality to the end-user of the products delivered as well as the taxpayer. Comparisons to alternative quality standards for Research, Development, Test and Evaluation (RDT&E) applications will also be made.

B. RESEARCH QUESTIONS

1. Primary Research Questions

a. What is the Background That Encouraged Institution of ISO 9001 Processes and Certification in the First Place?

b. What Has Been the Outcome of ISO 9001? That is, Has ISO Had the Desired Effect(S) and are the Environment/Situation/ Circumstances Still About the Same That Previously Led Up to the ISO Decision?

c. Is ISO 9001:2000 the Right Answer for Today's Acquisition Environment?

d. What are the Advantages and Disadvantages of Alternative Quality Management Systems/Processes?

2. Secondary Research Questions:

a. Does ISO 9001:2000 Registration Provide Benefits That Outweigh the Costs for a DoD Organization, Specifically the Range Systems Development Business Unit (RSDBU)?

b. Is ISO 9001:2000 Effective for an Organization, Such as the RSDBU, That Has Diverse Programs and Customers?

c. Is ISO 9001:2000 Effective for an Organization That Engages in Programs with Small Unit Production Quantities?

d. What are the Perceived Advantages and Disadvantages of Using ISO 9001 Today?

e. What are the Similarities and Differences Between the Application of ISO 9001:2000 to the RSDBU and Other Organizations, Both Government and Commercial?

f. Does ISO 9001:2000 Certification Increase Competitive Advantage for the RSDBU as a Navy Working Capital Fund (NWCF) Activity? Has ISO Certification Increased Funding or Prevented the Loss of Funding?

g. Are There Alternative Standards/Quality Management Systems That are More Appropriate for DoD Research and Development Organizations?

h. Is Application of ISO 9001:2000 Compatible with an Organization That is Highly Structured and Regulated, Such as DoD?

C. SCOPE OF THIS JOINT APPLIED PROJECT

This research uses the case of the Range Systems Development Business Unit. Analysis will focus on the RSDBU's approach to adopting a quality management system and the effectiveness of the process and implementation selected.

D. METHODOLOGY

In order to provide a better understanding of the benefits and issues involved with implementing ISO 9001, this research paper first provides an organizational overview of RSDBU and the rationale that went into selecting a quality management system. In order to accomplish this we utilized the following resources:

- Range Systems Development Business Unit Policy & Process Documentation
- Books, periodicals, journals, and electronic resources available at the Naval Postgraduate School (NPS) Library
- Internet websites pertaining to ISO 9001 and other Quality Management Systems
- Interviews with Senior Management and Team Leaders who are using ISO 9001

Then, we conducted an analysis of the effectiveness of the process implemented by the RSDBU. The end result of this case analysis is an evaluation on the effectiveness and impact of the ISO 9001 process on the business practices and program management efficiencies within the RSDBU.

E. ORGANIZATION

Chapter II, provides an overview of the specific ISO 9001 process adopted by the RSDBU. This is followed by an assessment of the effects, benefits and drawbacks of ISO 9001:2000 certification for the RSDBU.

Chapter III analyzes the use of ISO 9001:2000 in the broader Defense Acquisition Workforce and explore similarities and differences in the application of ISO 9001 between the RSDBU and other organizations, both government and commercial.

Chapter IV discusses the advantages and disadvantages of alternative quality management systems and processes and whether any of these alternative systems might be more appropriate for DoD research and development organizations.

Chapter V summarizes the findings of this research in the form of conclusions derived from this study followed by recommendations for the RSDBU and other government organization for improving the use of ISO 9001 as an organizational performance improvement tool..

F. BENEFITS OF STUDY

The results of this research will provide valuable insight into the potential application of ISO 9001:2000 to government organizations as a methodology for continuous improvement of customer satisfaction and delivered products and services. This case study will also examine the arguments of ISO 9001 detractors and assess whether the counterpoints to certification have merit based on the results observed in the period since the Naval Undersea Warfare Center (NUWC) Division Newport Range Systems Development Business Unit has become certified.

G. BACKGROUND – A DOD ORGANIZATION SEEKING STANDARDIZATION OF PROCESSES

NUWC is the undersea technology arm of the U.S. Navy's largest procurement organization, the Naval Sea Systems Command, (NAVSEA). Headquartered in Newport, Rhode Island, NUWC has two major subordinate activities: Division Newport (collocated with headquarters) and Division Keyport located in Keyport, Washington. In addition to its two main sites, NUWC has several detachments geographically spread across North America including Andros Island, Bahamas; Hawthorne, Nevada; Lualualei, Hawaii; San Diego, California; and Nanoose, British Columbia, Canada. Established in 1992, NUWC serves the undersea needs of both the surface and submarine communities by providing research and development of key undersea technologies to enable the vision of providing "the technical foundation which enables the conceptualization, research, development, fielding, modernization, and maintenance of systems that ensure our Navy's Undersea Superiority."[4] NUWC and its predecessor organizations have focused on disciplines related to undersea warfare for 130 years. Division Newport's roots go back to 1869, when the U.S. Navy established the Naval Torpedo Station in Newport to experiment with torpedo technology, explosives, and electricity. Newport predecessor organizations included the New London, Connecticut Underwater Sound Lab complex that was created during World War II to explore undersea acoustic technology. Division Keyport is the descendant of a Torpedo Station that was established in Washington in 1914.

In 1997, the NUWC Division Newport Executive Director authorized the merger of two departments into one new organization to achieve management efficiencies and reinforce similar core competencies. Senior management chose to use this opportunity to establish a new organizational structure better suited to current operating conditions and patterned after many successful commercial and government organizations. The new organization was created using the Competency Aligned Organization/Integrated Product Team (CAO/IPT) model, based on the principles of empowerment, communications, and teamwork. The new department, the Ranges, Engineering, and Analysis Department

---

4 NUWC Intranet, "Keeping America's Navy #1 in the World," Mission Statement, Updated June 18 2004.

(Code 70), provides full spectrum engineering resources, which enhances undersea warfare through the application of simulation-based development, undersea tracking range technology development, engineering analysis and design, fabrication, and systems for testing and training in representative environments.

A Department Head and Deputy Department Head provide the senior leadership for Code 70. The Deputy Department Head reports to the Department Head while sharing all the roles and responsibilities of the Department Head. Reporting directly to the senior leadership are the five Competency Leaders and a varying number of Team Leaders whose population is adjusted based on workload and program funding.

A Competency within this organization is a multi-disciplinary grouping of individuals who share common or synergistic fields of work through similar expertise and experience. The five Competencies comprising Code 70 include Algorithms and Software Development, Test Requirements and Conduct, Test Facilities and Operations, Technology Development and Application, and Prototyping and Development. The assignment of an individual to a particular Competency is based primarily on either the field of work for which an individual is most qualified or the type of work the department requires in order to meet current needs. Management-level decisions are guided by the Leadership Council composed of the Department Head, Deputy Department Head, and the five Competency Leaders.[5] In operation, the Competency Leaders' primary responsibility[6] is to provide qualified personnel for program execution, even though they, as functional leaders, are not principally involved in the technical or programmatic aspects of program execution. Conversely, Team Leaders are responsible for the technical and programmatic aspects of program execution, but not for personnel supervision or management. This benefits the Department and all of its personnel by allowing the Competency Leaders and the Team Leaders to concentrate full time on their respective responsibilities without the distraction and priority conflicts associated with mixing

---

5 NUWCDIVNPT, Engineering, Test, and Evaluation Department, Code 70 Concept of Operations, Revision 5C, January 2003, Section 10.0 and Appendix B.

6 The Leadership Council is a body that meets regularly to guide Department operations and to discuss long-term plans and policies. This council is a key element of Code 70's communications toolbox (refer to footnote #5).

programmatic and human resources responsibilities. Business Units were later established by forming groups of Teams focused on particular aspects of the business and customer bases.

1. The Business Unit Approach

For many years, Code 70 personnel have been the Navy's principal research, development and design organization for the installation and modernization of undersea tracking ranges. These ranges are used to provide testing for new Undersea Warfare (USW) systems and to support the U.S. Navy in fulfilling its continuing needs for USW proficiency training. Code 70 has supported undersea range customers across the globe, including ranges off the east coast of the United States, in the Bahamas, the Caribbean, southern California, Hawaii, the Pacific Northwest, as well as a foreign military sales case with the Australian government. Additionally, Code 70 manages and operates the Atlantic Undersea Test and Evaluation Center (AUTEC), a U.S. Navy range in the Bahamas, which is one of NUWC's largest programs. The Code 70 RSDBU was formed as a synergistic collective of cross-functional expertise to generate work plans and execute programs to maximize both cost effectiveness and capability delivered. The RSDBU consists of all Code 70 Program Team Leaders currently managing customer tasking related to the establishment, improvement, or modernization of an undersea tracking range. Members of the RSDBU have experience or specialization in areas including underwater tracking, in-water equipment installation, systems engineering, shore-based infrastructure, advanced distributed simulation, and ADP software and hardware development. Typical programs conducted by the RSDBU range anywhere from one-year $250,000 efforts to multi-year programs exceeding $20M in total cost. The membership of the RSDBU serves as the peer review forum for the sequence of reviews in each development program's life.

2. Influence from Economic and Business Factors

This core competency of undersea range systems design, installation and modernization is not consistently available in industry because of the limited customer base for large area, highly accurate undersea tracking combined with declining defense budgets that do not provide a steady demand, necessitating that this function be retained "in-house" within the government. Despite the global distribution of undersea tracking

facilities, the total number of facilities is limited due to the expense and complexity involved in tracking an object underwater. While the technologies employed are similar, the needs of the ranges and their customers are often sporadic and divergent, resulting in systems that operate from the same first principles of science but with innumerable variations of requirements and implementations. This results in a diverse customer base for the RSDBU, with differing goals for technology development and equally diverse program management styles and requirements.

The primary bifurcation of undersea tracking range requirements has been down the lines of fleet training as one major resource sponsor and the test and evaluation community as the other. Until early 2004, this divergence could be traced all the way back to the Pentagon where there were separate resource sponsors for Navy training ranges and test and evaluation ranges. These two resource sponsors worked through separate program management offices of the Naval Air Systems Command (NAVAIR), who provided individual tasking to the RSDBU teams. At the time of this study, the two resource sponsors are in the process of combining into a single Navy Range Office (NRO); consequently, the program management structure organization is currently in flux. Additional tasking is received from other organizations on a reimbursable basis for Technical Direction Agent (TDA) support and other implementations of undersea tracking range technology for missions such as projectile impact scoring in support of missile testing and Naval Surface Fire Support (NSFS) qualification and training.

With numerous customers comes a broad range of program management styles and reporting requirements. Prior to the pursuit of ISO 9001:2000 certification, no program management or quality management process was required by the Ranges, Engineering, and Analysis Department management for the execution of programs by the RSDBU. At a higher policy level, there is little guidance for government research facilities on the implementation and operation of a quality management system for products and services developed wholly or partially by government employees. Customer requirements vary from the imposition of a specific program-planning tool for budget and schedule estimates to monthly reporting of financial expenditures to simply measuring progress based on deliverable products. Within this environment, it was

essentially impossible to evaluate the quality of the products delivered to the customer in the context of the resources consumed, and equally vexing to derive lessons learned from projects that encountered problems during execution. These issues extended into the estimation of new work as well; without a consistent method of record-keeping, it was difficult to estimate new work based on past experience other than the corporate knowledge possessed by senior employees.

An additional factor necessitating efficient business processes is that NUWC is a Navy Working Capital Fund (NWCF) activity and as such, operates more like a business than a traditional government enterprise funded by a budget appropriation. The NWCF is a revolving fund relying on funded tasking from external customers rather than direct appropriations to finance its operations. As such, NUWC must generate sufficient revenue to cover the full costs of operations and finance continuing operations. Within these constraints, NUWC must operate on a break-even basis over time by neither making a profit nor incurring a loss.[7]

Within the defense acquisition milieu, sponsors, as customers, decide where to buy products and services based on performance records and cost competitiveness. Much like a commercial enterprise, NUWC gets orders for work from our customers, and subsequently bills them for the performance of that work. All of the money used to operate the Warfare Center, maintain infrastructure, and pay employees consists of funds received from customers for delivery of products and services. This contrasts with institutionally, or mission-funded, activities that are directly funded by Congressional appropriations.

Because NUWC operates as a NWCF activity, cost concerns influence business decisions. The need for funded tasking drives the requirement to be cost competitive in order to maintain a business base that supports the organization and the mission it fulfills.

---

7 OSD Comptroller iCenter, "A Little Background," http://www.dod.mil/comptroller/icenter/dwcf/background.htm, Accessed April 20, 2004.

Therefore, the organizational pricing strategy must strike a balance between recovering costs and enabling investment and recapitalization required to maintain the core mission capability of the Center.

Although NUWC operations resemble those of private businesses, there are major differences. NWCF activities are subject to controls, including financial, personnel, and procurement regulations, imposed by Congress, DoD, Department of the Navy, and NAVSEA as parent organizations. Furthermore, Congress exercises indirect control by establishing the appropriation levels of customer organizations. Customers cannot fund work at an NWCF activity if Congress does not fund their programs. Another distinction is the NWCF requirement to break even over time. The metric used to measure organizational financial performance toward this goal is the Net Operating Result (NOR). This break-even goal necessitates rigorous cost control to avoid a significantly negative NOR and creates incentives for the organization to ensure that customers are satisfied with delivered products and the associated budget performance.

The inherent fluctuation and variability in the business base for underwater tracking systems and components combined with the NWCF constraints incentivizes RSDBU members to remain vigilant to the appearance for new work opportunities, either domestically or abroad. Two Foreign Military Sales (FMS) opportunities appeared in early 2000 as solicitations — one from the Turkish Navy and one from the Royal Navy for acoustic measurement systems.[8] However, both organizations controlling the work required potential suppliers to have an ISO 9000 certified quality management system as a precondition to bidding. This event provided the initial impetus for considering certification, since the lack of certification had foreclosed a potential business opportunity.

During this time, the RSDBU was in the process of completing several major jobs, including the $17M task of replacing all of the in-water sensors at the Atlantic Undersea Test and Evaluation Center (AUTEC). The FY2000 and FY2002 budgets did not look promising from the perspective of containing major range system development

---

[8] Robert J. Reid , "RE: History Question," e-mail to Andrew Appleget, 29 March 2004.

programs that would fill the projected workload gap, so the RSDBU business development process began to emphasize smaller jobs in support of sustainment of the core equity.

3. Pursuing ISO 9001 Certification

With the RSDBU facing reduced workload from long-standing traditional customers, reevaluating organizational processes from the perspective of establishing new customers was necessary. Simultaneously, at the senior management level, interest increased in the documentation of work processes. Given the increasing focus on quality management in the commercial sector and the recently demonstrated requirement from FMS customers, ISO 9000 certification was examined to determine if institution of a quality management system would improve business processes and increase the potential to capture business from new customers. ISO 9001:2000 was considered in the context of other complementary efforts as well, including the Electronics Industries Alliance (EIA) Standard 632: Processes for Engineering a System (EIA 632) and the Capability Maturity Model Integration (CMMI) for software developed by the Software Engineering Institute (SEI) at Carnegie Mellon University.

The initial examination of alternatives began in February of 2000,[9] with discussions with other Division Newport departments on their initiatives in achieving ISO 9001:2000 certification as well as scheduling offsite meetings and presentations by contractors with expertise in the implementation of ISO 9000 compliant systems. After several months of deliberations, the decision was made in early November 2000 to form a "special projects team" that would become ISO 9000 certified.[10] The "special projects team" would later become the RSDBU as the Code 70 organization transitioned to the grouping of project teams into business units. The team/business unit approach to ISO certification was also highly recommended by both consultants and other NUWC Division Newport organizations that had pursued and/or achieved ISO certification. This approach was perceived to increase the chances for success on the initial certification audit by restricting the scope of the processes to be documented to those that had the

---

9 Dale L. Paquette, "Lead Engineer SITREP," e-mail to: #NPRI_70, 25 February 2000.
10 Ibid.

greatest commonality based on the work performed by the business unit. This approach also reduced the employees required to gain ISO 9000 proficiency to a more manageable number, thereby, simplifying the initial training process. Once initial certification had been achieved, additional work units could be incorporated based on the existing quality process manual and lessons learned from the initial certification audit and follow up compliance audits.

The primary concerns of pursuing ISO 9001:2000 certification were the cost involved in generating the quality manual and guiding procedures documentation as well as the additional overhead that would be imposed on programs in order to achieve and maintain compliance with the ISO quality policy. Additional documentation and program review requirements would effectively increase the cost to the sponsor for program execution. However, the Ranges, Engineering, and Analysis Department senior management made the decision to commit the required resources and proceed with the certification effort based on the presumption that the initial investment would reap benefits that would outweigh the costs. In an e-mail to all members of the Department on December 16, 2000, Richard Bonin, Head, NUWC Division Newport Ranges, Engineering, and Analysis Department (Code 70) formally announced the Department's commitment to achieving ISO 9001:2000 certification:

> For much of the past two years, we have examined the merit of documenting Code 70's various processes. To date, we have made some progress, especially in software engineering, but not nearly enough to reap the benefits of doing so. This is especially true in the field of program management and systems engineering which are the mainstays of a significant part of Code 70's business. It is crucial to our financial future that we develop and instill a sense of discipline into these areas ensuring that our planning and cost estimates and, therefore, our progress against requirements, budget, and schedule are accurate. Performance to plan will enable us to bid, win and compete for future projects. We will avoid submitting non-competitive bids or underbidding and damaging our financial viability. Documented processes will also enable us to better view and understand the technical work being performed by our teams. Often, external project insight can enable a team to take advantage of the knowledge, skills and experiences of others to identify unseen problems, insert new ideas, and to avoid duplicating work which has already been done elsewhere. Most projects face adversity usually resolved at some expense in time and money. The lessons learned in these experiences

> need to be documented and made available to all teams. This transfer of lessons learned will offer on-going [sic] projects the opportunity to avoid [costly mistakes] or rapidly implement the optimum solution for similar problems, improving our efficiency. Lastly, we have already missed the opportunity to bid on two Foreign Military Sales (FMS) jobs because we are not an ISO 9001 certified organization. FMS represents a potentially profitable future business base for Code 70. ISO 9001 certification can only be accomplished by documenting our processes, following our processes, and being able to prove to an external auditor that we do follow them.[11]

The initial Department process documentation approach was not solely centered on ISO 9001:2000. The Algorithm and Software Development Division had been pursuing software CMMI process development and certification in parallel through consultations with SEI representatives under contract to DoD to foster increased use of the CMMI standard. EIA 632 was used as the framework for the development of the Design Control document since that process required the most tailoring to fit the specific needs of the Department. The original intent was to use these processes as complementary approaches across the majority of the Department's business areas:

> In consideration of the above, we have begun several formal process documentation efforts. Many of you are familiar with our CMM efforts relating to software. So far, we have four separate projects requiring software development participating in this effort. You may also have heard of our EIA-632 systems engineering efforts. This document lays out a blueprint for system engineering and is easily adaptable to Code 70 projects. Finally, there is ISO 9001, we have formed a Special Projects Team and are diligently working to get this team certified so that we may bid FMS work. Both the MONET [Miniature Optical Node for Environmental Testing] and the LSVTC [Land-Sea Vulnerability Test Complex] projects are working with this team and will be the first instances of our doing ISO 9001 work. Also, there is now a Systems Engineering Functional Team, which is working to standardize some of the processes and standards used in systems engineering. Please note that these various efforts are fully coordinated. Specifically, ISO 9001 will be the top level set of processes with EIA-632 and CMM applying heavily to

---

[11] Richard L. Bonin, No title, e-mail to #NPRI_70, 16 December 2000.

> the technical aspects of the systems engineering work. In fact, EIA-632 will invoke CMM when software engineering and development are called for.[12]

As illustrated in this e-mail, the intent of senior management was to develop a methodology to standardize processes for all of the Department's business areas in order to retain and improve the Department's standing as the provider of choice for the products and services that represent the mainstays of the business base. The Department Head also made the determination that the costs of development of process documentation and the associated increase in administrative costs during execution of a program operating under ISO 9001:2000 processes were worthwhile:

> As the above work progresses, there is an important ramification for the rest of [the undersea range product side of] the department. In order to be a process driven, ISO 9001 organization the utilization of these processes cannot be discretionary. I recognize there can be difficulty in terms of time and expense in applying these processes to established projects. However, it is prudent and far less difficult to apply them to newly beginning projects. I would like to inform all Team Leaders, aspiring TLs and project team members that all new projects beginning from this fiscal year (2001) and on will be required to conform with the developed processes.[13]

The approach of senior management to the documentation of Department processes demonstrated a firm commitment of resources and effort toward the establishment and improvement of a defined business model that would facilitate both prudent management decisions as well as customer understanding of the contributions of the Engineering Test and Evaluation Department to the undersea warfare community. While pursuit of ISO 9001:2000 certification was initially motivated by a desire to increase the FMS business base, added benefits soon became clear.

The ISO 9001:2000 certification process began in November of 2000 with the formation of an internal Department team to generate the quality manual and guiding procedures documentation and assess the actions required to establish ISO 9001:2000

---

[12] Ibid.
[13] Ibid., Pt. 3.

compliance amongst the participating programs.[14] This team explored the requirements for ISO 9001:2000 certification and worked to tailor the implementation of the ISO 9001:2000 standard to the specifics of the RSDBU business base as well as the policy requirements of a DoD organization. During a March 2001 brief to Program Team Leaders at a management offsite meeting, the expected benefits of adopting an ISO 9001:2000 quality system were defined to include: the establishment of Department credentials to customers, achievement of greater consistency in program planning and execution, achievement of greater consistency in technical methods, and the overall objective of consistently making Department customers successful.[15]

By June of 2001, the ISO 9001:2000 documentation process was nearing completion[16] and preparations for an internal compliance audit in preparation for the third-party registrar audit began. Perry Johnson, Inc. was selected to perform the registration audit on the basis of corporate familiarity with federal government organizations seeking certification. An internal pre-assessment of process documentation was conducted in September of 2001 followed by an internal audit of RSDBU member program compliance and a mandated management review in mid-October. The certification audit took place on 22-23 October 2001, with only minor non-conformances and one corrective action noted. Once these issues were corrected, the RSDBU was certified to the ISO 9001:2000 standard.

---

[14] Robert E. Janiesch, "Coordinating Systems Engineering, ISO 9001 and CMM to Code 70 Programs," Presentation to Team Leaders, 26 March 26 2001, Slide 4.

[15] Ibid., Slide 3.

[16] Robert E. Janiesch, "ISO 9001:2000 Rollout for the Range Systems Development BU," Presentation, 8 June 2001, Slide 5.

THIS PAGE INTENTIONALLY LEFT BLANK

II. EFFECTS, BENEFITS AND DRAWBACKS OF ISO 9001

A. INTRODUCTION

The purpose of this chapter is to provide an overview of the specific ISO 9001 process adopted by the Range Systems Development Business Unit (RSDBU). This is followed by an assessment on the effects, benefits and drawbacks of ISO 9001:2000 certification for the RSDBU.

B. OUTCOME OF ISO 9001 CERTIFICATION

The RSDBU has been certified as an ISO 9001:2000 compliant organization for over two and a half years as of this writing. As discussed in Chapter 1, the ISO 9001:2000 certification process was undertaken as part of a broader process documentation initiative that included the use of CMMI for the software development group as well as EIA 632 for the system engineering team. Key elements of these three processes were used to generate the Design Control Process, which is the core management process followed by every program within the RSDBU. During that time, the operating environment for the RSDBU underwent changes similar to the rest of the defense acquisition community as the transformation from a Cold War force structure to an instrument to combat global terrorism continues.

The fiscal environment for the RSDBU has remained turbulent in the post-September 11, 2001, defense acquisition drive toward defense transformation. The Chief of Naval Operations (CNO) has retained his "Top 5 Priorities"[17] as:

1. Manpower
2. Current Readiness
3. Future Readiness
4. Quality of Service
5. Alignment

---

[17] Navy Office of Information, "Top Five Priorities," http://www.chinfo.navy.mil/navpalib/cno/cno-top5.html, Accessed April 20, 2004.

As a Navy research and development organization, the RSDBU offers value to the Navy in the context of supporting the achievement of both current and future readiness. This is accomplished by enabling more effective readiness preparation through the development of undersea tracking systems and assessment tools for fleet training exercises as well as providing the facilities, analysis tools, and planning services to enable test and evaluation of developmental undersea warfare systems. Budget constraints have intensified in support of ongoing military actions associated with the War on Terrorism, resulting in continued pressure to achieve efficiencies in defense procurement activities. Major changes are in process at the Navy systems command levels, including the realignment of the NAVSEA laboratories to better pursue the CNO's Sea Power 21 vision.

Within this strategic context, the value of a documented quality management system can provide an important organizational credential to demonstrate a commitment to Navy and DoD transformational initiatives and the achievement of mandated efficiencies. The increased priority on homeland security and protection of domestic infrastructure continues to reinforce the need to demonstrate the value added of all activities throughout DoD. Utilizing a quality management system with inherent process controls provides one avenue to demonstrate commitment to delivering products that are optimized to meet the requirements of today's warfighter within the fiscal constraints imposed by an evolving threat environment.

At the operational level, the requirements of an NWCF activity and the business base of the RSDBU support the case to have a quality management system that efficiently enables the conduct of smaller scope defense acquisition programs. There is no current guidance or policy from the Secretary of Defense (SECDEF) or Secretary of the Navy (SECNAV) levels on the internal use of ISO 9000 by NAVSEA field activities.[18] While the DoD 5000 series of instructions provide policy guidance on the implementation of

---

[18] Department of the Navy, Application of the International Organization for Standardization (ISO) 9000 Series Quality Standards in NAVSEA Programs, NAVSEAINST 4855.33, 19 February 1997, P 2.

quality management for procurements as part of Major Defense Acquisition Programs (MDAPs), they do not address internal government activities that directly or indirectly support MDAPs.

The RSDBU business base is primarily composed of smaller programs indirectly supporting MDAPs, as well as non-MDAP tasking, enabling current fleet readiness through the provision of products and services. In this context, it may be perceived as having limited utility to invest scarce resources in quality management practices for programs that generally range in size from $100K to $20M. However, the NWCF structure creates a management incentive to ensure that the DoD workforce is appropriately sized to meet current and future requirements based on funded tasking from resource sponsors. The resultant motivation to minimize overhead and associated indirect costs while continuing to deliver quality products that support military customer requirements mandates that quality assurance is implemented in an efficient and cost-effective manner. Quality and affordability are significant driving requirements for all organizations, both government and commercial, seeking to remain relevant in the current DoD fiscal environment.

Efficiency motivations also continue to drive commercial activity initiatives of current and previous political administrations through assessments of inherently governmental activities and analysis of "core equities." Core equities are capabilities that do not exist in private industry due to lack of stable demand, but are required to enable the provision of affordable military capabilities and therefore inherently governmental. To support these core equities, prudent management practices dictate the diversification of the customer base to ensure that these functions are maintained at a reasonable cost to the taxpayer.

An effective quality management system supports both the goals of an adequate business base and an effectively sized workforce by providing a quality management structure that can be tailored to the smaller size of the programs conducted by the RSDBU and maintained without onerous indirect cost burdens to the customer. In the international defense arena, an ISO 9001:2000 certification serves to establish the

imprimatur necessary to enable leveraging of allied nations' military investments in support of the maintenance of the RSDBU core equity of designing and installing systems for undersea tracking.

The foregoing evaluation of the evolution of influences of the external environment reveals that the conditions that initially inspired the RSDBU process documentation initiatives, including an ISO 9001:2000 certified quality management system, warranted the pursuit of process documentation objectives. The ongoing instability of operating in a transformational environment continues to validate the need for a quality management system that efficiently enables improved deliverables from a government organization. Based on that premise, it is necessary to determine if the process documentation and quality management system implementations have been beneficial for the RSDBU.

Since the achievement of ISO 9000 certification, the process documentation initiatives within the Ranges, Engineering, and Analysis Department have stabilized to an emphasis on maintaining ISO 9001:2000 certification as the primary implementation of a quality management system. EIA 632, which served as the blueprint for the system engineering process, was used as the template for the development of the Design Control Process for the RSDBU, and the System Engineering Functional Team (that drafted the Design Control Process) continues to use that as a reference when and if the process requires updates. The software CMMI certification effort was deferred after an initial qualification audit did not achieve CMMI Level 2 certification. Although several Level 3 and 4 Key Performance Parameters (KPPs) were being met, one of the KPPs required to achieve Level 2 that was not being met was establishment of an independent testing group. Each program is generally responsible for planning and executing the testing of all components being developed and delivered to the customer. Establishing and maintaining an independent testing group was not considered a trivial effort. The conclusions drawn by the Ranges, Engineering, and Analysis Department from that audit found that the resource requirements of achieving and maintaining a CMMI documented process exceeded the benefits that would be obtained for the business base of the Software Functional Team. Although CMMI Level 2 certification is no longer being pursued at this time, the KPPs that can be applied and implemented within the Software Functional

Team are still being followed. The need for a strong process for dealing with customer requirements, feedback, and satisfaction convinced the RSDBU to continue its focus on following ISO 9001:2000 for overall program management, while using EIA 632 and CMMI elements to cover the engineering development aspects of all programs.[19] Since the Software Functional Team primarily serves internal customers within the Code 70 organization, their members are assigned to the various Program Teams of the RSDBU as well as other teams. Since the RSDBU Team Leaders follow ISO 9001:2000 as their driving quality management requirement, software developers must be trained and follow the tenets of ISO, which provides a level of process conformity. While this process conformity is not specifically tailored to the software development environment, it provides enough guidance to ensure that the needs of individual programs are met and the software products delivered fulfill the requirements of the overall delivered product.

The Code 70 quality management system has continued to mature through the continuous improvement tenets of the ISO 9001:2000 standard and expand to other areas of department business. The Dodge Pond Acoustic Testing Facility, another portion of the Code 70 enterprise that conducts underwater acoustic transducer testing and calibration, implemented a process documentation initiative and was certified to the ISO 9001:2000 standard in June 2004. Within the RSDBU, periodic internal surveillance audits required to maintain ISO 9001:2000 certification discovered process anomalies and areas where corrective actions were not entirely successful. The most recent internal audit conducted in March 2004, discovered three instances of nonconformance to process, five observations and one major nonconformance resulting in the reopening of a corrective action report (CAR).[20] Resolution of the CAR required the development and implementation of an additional work instruction to formalize the process for getting internal customer concurrence on requirements for development programs delivering

---

19 Boris Mutafelija and Harvey Stromberg, "ISO 9001:2000 -- CMMI v1.1 Mappings," Carnegie Mellon Software Engineering Institute, July 2003, http://www.sei.cmu.edu/cmmi/adoption/iso-mapping.pdf, Accessed April 20, 2004.

20 NUWCDIVNPT, Code 70, "ISO 9001:2000 Management Review, Range Systems Development Business Unit Review Meeting," Presentation briefing, 16 March 2004, P. 3-6.

products to the AUTEC range. These results indicate that Code 70 management remains committed to the retention of ISO 9001:2000 certification by maintaining the continuous improvement process.

From a process maintenance perspective, the direct costs of the Code 70 ISO 9001:2000 system have remained a worthwhile investment for Code 70. Currently, the ISO 9000 management representative role is filled as an additional duty by the Deputy Competency Leader who is also the leader of the RSDBU, requiring no additional financial investment as the Deputy position is overhead funded. The internal audit team is composed of one government employee working part-time on ISO tasking and contractor consultation for ISO 9000 process and documentation expertise. These labor costs, combined with the fee for the annual third party certification audit, total approximately $50,000 for FY04.[21]

During FY04, the RSDBU is executing $19.5M of customer funding including $7.6M of Code 70 internal labor,[22] so the traceable direct cost of maintaining certification represents 0.3% of the total RSDBU budget.. This comparatively miniscule investment has proven sufficient to sustain RSDBU processes at a level necessary to maintain certification as well as managing the administration of the program review process. It is not possible to determine the indirect costs to individual programs for maintaining ISO compliance without adding unreasonable burden on Team Leaders and team members. An attempt to definitively quantify the additional costs imposed by the RSDBU ISO process would be counterproductive from the perspective of differentiating efforts directly attributed to ISO 9001:2000 compliance as opposed to non-ISO required program management activities.

While the indirect compliance costs to individual programs cannot easily be determined, it has been the authors' experience that there is little additional administrative and financial burden added by RSDBU quality management system requirements. Most of the documentation required by the RSDBU quality management system is consistent with

---

21 Doris Carvalho, phonecon, 15April 2004.

22 Code 70 financial data and AUTEC I&M program status briefs derived from multiple internal sources.

sound program management practice, the additional ISO-specific requirements such as cover sheets and tracking tags, create negligible impacts on employees' time and productivity. Productivity gains can also be achieved through better program organization driven by the ISO process.

The most significant program impact is found in preparing for the conduct of reviews mandated by the *Program Review Process* work instruction. Since RSDBU sponsors require varying levels of progress and status reporting detail from Team Leaders, fulfilling the RSDBU ISO program review requirements can consume additional time in collecting and formatting ISO-required information at the level of detail specified in the instruction. Program reviews generally occur one to two times per year and are event-driven by the progress of the program; a total of six reviews (excluding the initial task review) are required by the RSDBU process.

Based on the authors' experience, no more than 20 – 40 total team work-hours are usually required to prepare for each review depending on the size and complexity of the program. This level of effort is not a significant expense for RSDBU programs and has been streamlined, in comparison to previous program review methods, by the RSDBU ISO 9001:2000 quality system. The use of a common program review format provides a documented baseline to which Team Leaders can plan, and thereby budget, when programs are proposed. A common process facilitates the mapping of data elements from program planning and execution tools to the program review requirements with nominal additional effort required to maintain ISO 9001 compliance. ISO 9001 specific requirements are generally limited to fulfilling documentation requirements, such as verifying record cover sheets and ensuring document revisions are current.

From an external perspective, it is challenging to quantitatively assess specific benefits that have been achieved in customer satisfaction or changes in the quality of delivered products as a result of achieving ISO 9001:2000 certification. As part of the ISO 9001:2000 processes adopted by the RSDBU, as illustrated in Figure 1, the measurement of customer satisfaction is a required input to the establishment and monitoring of business objectives. The most cost effective way to assess customer satisfaction is through the use of surveys focused on specific factors of interest, as opposed to the

alternative of conducting individual interviews, which can be costly in terms of schedule, travel, and lost productivity.

NUWC Division Newport has instituted a Division-wide customer survey process in support of the unit self-assessment requirements of the NAVSEA Inspector General.[23] Customers, in the form of principal stakeholders (including fleet commands and type commanders) and resource sponsors, are annually provided with a customer survey to determine their satisfaction with the products and services delivered by Division Newport organizational entities. Sponsors to be surveyed are derived from assignment numbers allocated by the financial system and correspond to those people responsible for providing funding documents while stakeholders are identified by senior management.

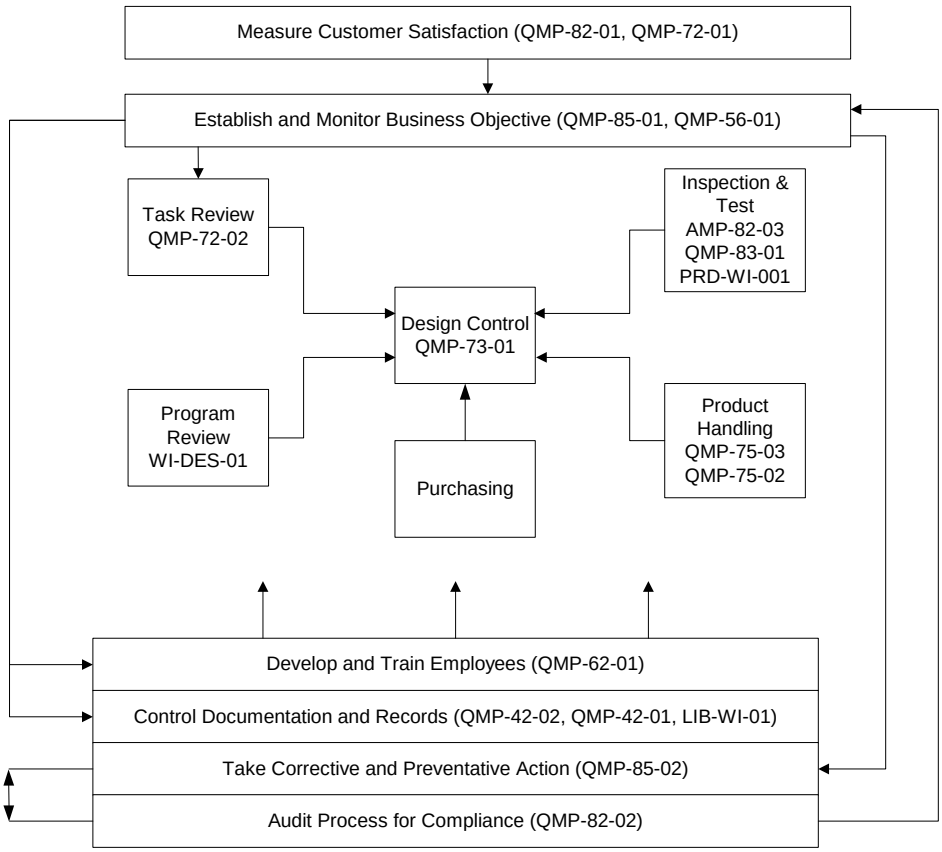

Figure 1. Code 70 Process Interaction Diagram

23 NAVSEA, "NAVSEA Command Performance Inspection (CPI) Team 6 Improvements," 21 September 1999.

Historically, the survey responses from Code 70 customers have averaged a 30 – 50% rate of return and involve less than 20 individual responses, so it is difficult to derive statically significant data. For example, the most current data available for FY02 showed an increase in customer rated quality of delivered products of 8% over FY01, as opposed to a 3.6% decrease in customer rated quality from FY01 to FY00.[24] However, since the Code 70 survey data also includes customers of non-RSDBU members it is impossible to quantitatively assess the impact of ISO 9001:2000 certification on customer satisfaction based on these survey results. A lack of "before and after" pairings of survey responses from a sufficient number of either ISO-controlled or non-ISO-controlled programs prohibit this quantitative assessment. This issue was noted as an ongoing observation during the past two Code 70 ISO management reviews. As a result, alternative customer survey methodologies are being considered that are tailored to Code 70-specific business objectives management and which more directly support the ISO process.

The primary metrics used by most customers to evaluate RSDBU performance are cost, schedule and performance. Some programs are also evaluated on budget execution since that is a metric used by comptrollers of the Navy, other services, and DoD to evaluate program managers that provide tasking to the RSDBU. While the RSDBU ISO 9001:2000 system is not aimed at facilitating budget execution, it does address cost, schedule and performance as components of product quality and earned value. Also, the preponderance of RSDBU customers are government activities that do not require a quality management system as a precondition for tasking and do not operate internally under a quality management system.

Therefore, the RSDBU ISO 9001:2000 quality management system seems unlikely to influence customers' decisions on providing tasking to the RSDBU on the basis of their organizational culture or program management requirements. It has been the authors' experience that RSDBU operation under an ISO 9001:2000 quality manage-

---

[24] Code 70 customer survey data FY02 summary, compiled and retained within Code 70

ment system has not been used as a marketing tool with most sponsors and at most has been only peripherally mentioned during the course of sponsor program reviews.

From this analysis, the RSDBU ISO 9001:2000 quality system is unlikely to have a significant impact on customer perception of value added, so it is necessary to consider if there is an indirect benefit created by facilitating more effective execution of sponsor tasking through the improvement of internal RSDBU processes. At a top level, this objective can be found in the Code 70 Quality Policy:

> Our goal is to consistently provide systems that satisfy our customers by meeting or exceeding their quality requirements and expectations including, but not limited to, system performance, cost and schedule. This will be accomplished by maintaining a constant commitment to process evaluation, innovation and continuous improvement.[25]

This policy provides the foundation for the Code 70 quality management system and summarizes the intended value added of the system.

Another method to assess the overall effectiveness of the Code 70 system is by examining the progress achieved toward the original senior management expectations of certification benefits as laid out in the Code 70 policy issued in December of 2001. The e-mail promulgating the Code 70 process documentation policy laid out four major expected benefits:[26]

- Instill discipline in planning and cost estimates
- Better understanding of technical work being performed across the organization
- Ability to bid on FMS work requiring ISO 9000 certification
- Documentation of lessons learned

The overall perceived advantage of a process documentation approach was based on using ISO 9000, CMMI and EIA-632 processes to accomplish improved organizational performance of program management and system engineering functions and

---

[25] NUWCDVINPT, Code 70 Departmental Business Unit and Cost Center Quality Processes Manual, (Level I Document), 3 May 2004, P. 24.

[26] Richard L. Bonin, No title, e-mail to #NPRI_70, 16 December 2000.

improving the product realization activities (such as software and digital signal processing system development) that are significant components of most RSDBU deliverable products. The following evaluates each of the expected benefits based on 30 months of experience with the process to date.

1. Instill Discipline in Planning and Cost Estimates

The overall RSDBU process, as illustrated in Figure 1 and detailed in the Program Review Process work instruction, mandates a Requirements Review prior to commencement of new work.[27] This review is conducted upon receipt of a funded tasking to ensure that the project was adequately scoped within the bounds of available technology, workforce resources, and has a realistic budget and schedule. However, since this review occurs *after* the receipt of a funded tasking, the proposal that was forwarded in order to receive the tasking has already been generated and accepted by the customer, thereby creating an agreement that has established customer expectations for cost, schedule and performance. Therefore, the Requirements Review, as the first component of the Design Control Process, does not fulfill the goal of ensuring that the proposal provided was adequately scoped in terms of deliverables, schedule, and cost, since the RSDBU had effectively accepted the tasking by the time the Requirements Review was conducted.

The solution to this issue was the inclusion of a separate review, called a Task Review, which is required "when the proposal under consideration has a value of at least $200,000 or is proposing at least one half man year of labor for Code 70."[28] This methodology was adopted to provide greater consistency and rigor in proposal review and to ensure that varying aspects of a project were appropriately scoped prior to a proposal being released externally to potential sponsors.

The Task Review can be conducted in one of three of ways: a formal presentation to available business unit members, electronic distribution to business unit members for review and comment, or expedited review by Code 70 senior management for cases where an informal proposal or rough order of magnitude estimate is required on short

---

[27] NUWCDIVNPT, Ranges, Engineering and Analysis Department (Code 70) Range Systems Development Business Unit, Design Control, Doc. No. RSD-QMP-73-01, Rev. 3, 24 February 2004, P. 17.

[28] NUWCDIVNPT, Code 70, Task Review Work Instruction, Doc. No. RSD-QMP-72-02, Rev. 4, 17 November 2004, P. 2.

notice.[29] The multiple modalities of the task review process provide flexibility to ensure an appropriate level of scrutiny is applied based on the scope and size of the proposal, potential labor resource impacts, and the time available for proposal generation. The electronic distribution alternative also helps mitigate the constraints of a geographically distributed organization and the frequent travel schedules of RSDBU members.

The task review process is designed to include representation from all of the RSDBU disciplines, such as in-water installation, shore systems electronics, digital signal processing, and ADP software, to review a proposal for adequacy of cost, schedule, and resource estimates. This approach takes into account the experiences and lessons learned over a broad spectrum of disciplines. Since the RSDBU is composed of a number of specialists in varying disciplines, it is challenging for any individual member to develop a proposal with a broad scope of work, based only on their individual experience.

Fifteen task reviews have been conducted since the inception of the task review process in September 2001.[30] Of those, seven have been formal presentations, six have been conducted via e-mail and two were completed by senior management review. Attendance at formal reviews averaged 20-25 employees, including RSDBU members, team members and management. The comments generated as a result of these reviews range from notations of grammatical errors, to missing documentation or information required by the task review process, to perceived technical shortfalls or implementation risks of the proposed scope of work.

Since the proposal is reviewed by employees with a broad collection of skills and experience, portions of the proposal that may be unclear to people who are not specialists in the primary discipline of the proposal will be revealed before the proposal is submitted. A proposal may be perfectly clear to the employee who generated the proposal, but by having the proposal reviewed by employees with a different skill mix and technical perspective provides a "sanity-check" to ensure that the intent of the proposal is clearly communicated to someone without a specialized technical background

---

[29] Ibid., P. 3.

[30] Information resides on Code 70 ISO Folder located on global drive (\\Npri70fs\global\ISO\Review Minutes\Task Reviews).

in the subject of the proposal, as is often the case with resource sponsor personnel. The use of a broad-based internal peer and management review also helps motivate employees generating proposals to "sharpen the pencil" and ensure that planning and estimation are accomplished with sufficient rigor before a proposal is released.

The task review process has been updated three times since its initial release[31] and a fourth revision is in process to expand the scope of the process to include proposals submitted for Major Range Test Facility Base (MRTFB) funding, which are currently exempted. While some proposals have been released without the benefit of a task review, conformance has generally been increasing as the new process gains wider comprehension by RSDBU members and is reinforced by management. Overall, this process can be judged as meeting initial expectations for improving the rigor of planning and cost estimates.

2. Better Understanding of Technical Work Being Performed Across the Organization

The evolution of Code 70 as the Ranges, Engineering, and Analysis Department has brought together a diverse collection of technical specialties and facilities within a common management structure. However, because of this diversity it is challenging, if not impossible, for employees or senior management to maintain an in-depth currency in the science and technology that is being employed across the entire organization. This situation created the initial motivation for the formation of business units as a form of "communities of practice" for areas of tasking with technical and/or customer commonality. The business unit construct also proved convenient when it was necessary to identify a collection of people and programs for the purpose of seeking ISO 9001:2000 certification by identifying the RSDBU as the organization to be certified and developing processes tailored to that specific business area.

The program review process mandates a comprehensive overview of the current program status including a summary of program documentation content and external review status, a summary of the tasks accomplished for the phase(s) being reviewed,

---

31 Task Review Work Instruction, Doc. No. RSD-QMP-72-02, Rev. 4, 17 November 2004, P. 1.

status of Environmental Review Board approvals, significant program issues, significant technical issues, an assessment of personnel resources available for executing the program, and current risk assessment and mitigation plans.[32] These components are mandatory for all programs and provide senior management with a convenient and standardized oversight mechanism.

The RSDBU is composed of a wide array of programs, including the implementation of advanced modeling and simulation systems at open-air tracking ranges, ADP software development, acoustic telemetry system design, in-water sensor fabrication and installation, digital signal processing development, and electronics design. The function of the RSDBU is to ensure that these and other elements are combined to deliver a cohesive and optimized level of capability to the Navy in a cost-effective and timely manner through leveraging of technologies developed across the spectrum of individual tasks received from sponsors with often disparate requirements.

Against this backdrop, the RSDBU program review process provides a common template as a progress review mechanism and facilitates increased understanding of technical work being performed across the organization. The structure of the program review process requires that Team Leaders present the technical approach and evolving design status over the course of the program life cycle until the system or capability is delivered. Also, since attendance of the all of the available business unit members is required at Design Control Process reviews, these reviews also serve as ersatz technical forums to provide a nominal level of education to other business unit members on the current status of various technologies that are critical to the RSDBU business base. The review process also serves to help educate new employees in areas outside their technical specialization. An added benefit of the review process is in the designation of ISO program reviews as fulfilling continuous learning objectives for the Defense Acquisition Workforce Improvement Act (DAWIA) program required for all Code 70 employees.

---

[32] NUWC Division Newport, Code 70, Program Review Process Work Instruction, Doc. No. RSD-WI-DES-01, Rev. 3, 20 October 2003, P. 1.

3. Ability to Bid on FMS Work Requiring ISO 9000 Certification

Although competing for FMS opportunities was the initial impetus to pursue certification, it has turned out to be one of the areas with the least return on investment. Since achieving ISO 9001:2000 certification, the RSDBU has not gained any FMS work for which ISO 9000 certification was a prerequisite. However, Code 70 currently has six active data exchange agreements with Australia, Sweden, Norway, France, the Republic of Korea and Japan[33] that have the potential to lead to FMS business opportunities. FMS cases tend to take a significant amount of time to develop due to the inherent complexities of international transfer of defense technology and the associated regulatory and policy coordination. Also, given the changes in the global defense posture as a result of the War on Terrorism, many countries are scaling back their investments in undersea tracking technology as their priorities have shifted to homeland defense and anti-terrorism initiatives.

4. Documentation of Lessons Learned

The Program Review Process also serves to establish a common framework for documenting lessons learned from a program execution perspective. Having a standardized documentation format serves to ensure that all programs provide the same types and amounts of data that can be analyzed and compared for future reference.

Before the establishment of the RSDBU and ISO 9001:2000 certification, program documentation format and possession was the sole purview of the Team Leader running the program, usually driven by sponsor requirements. Often, when employees transferred to other jobs or retired, their records were inherited by remaining employees or put into storage. For those receiving such an inheritance, filing systems tended to be personality specific and it was often difficult and time consuming to attempt to reconstruct program history from the remaining documentation. Within the RSDBU ISO process, program documentation requirements are specific and consistent for all programs, thus simplifying the reconstruction of past experience and corporate knowledge. Individuals specializing in program documentation are becoming more

---

33 NUWC Division Newport, Code 70, "Training, Test and Evaluation Department, Code 70, Department Brief." Overview presentation, 10 June 1999.

proficient through the documentation standardization and process control. Also, the shift to electronic file storage helps to facilitate access through the filing of program data records in a common location.

As with others, this facet of process control will take time to gain footing and provide benefit as programs transition to the new documentation paradigm and corporate history migrates to a standardized format. While no documentation effort can efficiently capture all corporate knowledge resident with technical experts, a common format will increase the productivity of both current and new employees as they seek to benefit from previous experience.

The previous examples illustrate the results achieved by RSDBU ISO 9001:2000 certification in the context of the benefits expected by senior management at the time the decision was made to pursue certification. However, there have also been other effects of certification beyond the scope of those initially anticipated.

Consistency of process has proven beneficial by providing documented and uniform expectations of team leaders and team members not only in program planning but also for program execution. Since the ISO 9001:2000 mandate is management driven externally to a program, potential conflict amongst team leaders and members is reduced or eliminated with respect to program reporting requirements. For functional teams that work across multiple programs, such as software development, there is also consistency from program to program on reporting requirements as well as the conduct of peer reviews in support of the program review process. For Team Leaders managing more than one program, the RSDBU ISO 9001:2000 process provides similar benefits in the imposition of consistent status reporting and review development products.

The nature of the RSDBU ISO 9001:2000 implementation also lends itself well to program execution due to the inherent tailoring that occurs in any instantiation of an ISO 9000 process. Thus, work instructions and procedures are generated only for those elements that require process documentation above and beyond existing policy or regulatory guidance. For example, since purchasing in a DoD organization is controlled by Federal Acquisition Regulations (FAR) and Defense Federal Acquisition Regulation

Supplement (DFARS) directives, there is no need to generate separate work instructions for the conduct of purchasing since the FAR and DFARS are acceptable to ISO 9000 registrars as documented procedures.

The consistency of the RSDBU ISO 9001:2000 process also provides benefits during personnel changes for team members and leaders. Since every program is documented to the same standard and undergoes the same set of internal reviews, the process of replacing personnel due to transfers or retirements is simplified for the person assuming new responsibilities. This provides efficiencies to the program sponsor by reducing the learning curve as well as removing any concerns the sponsor may have about the process that the new team leader will be using to manage their program.

Finally, in the age of "rightsizing," an ISO 9001:2000 certified quality management system helps to fulfill the requirement of commercial activities studies for the Most Efficient Organization (MEO) to have a Quality Assurance Surveillance Plan (QASP). "The QASP describes methods of inspection, performance metrics, required reports, and the needed resources, including estimated work hours, to verify quality" and is "key to the successful inspection of contract, ISSA [Interservice Support Agreements], or in-house performance."[34] A government organization that has previously implemented an ISO 9001 compliant quality management system can save the time and expense of meeting the QASP requirement in an expedient fashion within the schedule of a commercial activities study; thereby, increasing the chances of being selected as the MEO.

In summary, the conclusion can be drawn that the implementation of an ISO 9001:2000 quality management system has provided benefits for the RSDBU as an organization. The evolution of the external strategic environment of the RSDBU has increased the need to be able to demonstrate organizational value added to the Navy, and a documented quality management system contributes to the achievement of that goal.

---

[34] Chief of Naval Operations, "Navy Commercial Activities (CA) Program," OPNAVINST 4860.7C, 7 June 1999, P. 1-24.

To date, the most significant drawback is that the establishment of a certified RSDBU quality management system cannot be shown to have achieved a direct financial return since it is not provable that ISO 9001:2000 certification directly led to new work or the retention of existing work. However, it has been shown that the improvement in business unit processes provides value to customers in terms of business practices that create consistent program execution requirements, heightened management visibility of program performance and the associated employee motivation to ensure customer expectations are achieved.

The next step is to assess the effectiveness of the RSDBU ISO 9001:2000 quality management system in the execution of programs.

C. EFFECTIVENESS OF ISO 9001:2000 FOR THE RSDBU

As previously stated, the RSDBU operates across a diverse set of product realization disciplines when compared to many other organizations that have been certified to the ISO 9001:2000 standard. Since the ISO 9001:2000 standard evolved from a product manufacturing background, it is necessary to examine the effectiveness of the standard when used in an organization that is primarily focused on research and development with commensurately increased levels of risk and uncertainty in comparison to a strictly production oriented organization. The necessity for the RSDBU to cultivate a diverse set of customers and deliverable products to maintain the core capability of the workforce could lead to the conclusion that a common quality management system is a suboptimal solution.

In this context, it may seem counterintuitive to apply a quality management standard that emphasizes conformity to an organization whose outputs are markedly non-conforming in terms of a specific product or narrowly-focused product line. Since the ISO 9001:2000 process emphasizes conformity, inspection and corrective action, an assessment of effectiveness may be found in the examination of programs that have experienced problems in achieving cost, schedule or performance milestones.

Since the achievement of the RSDBU ISO 9001:2000 certification, only one program has been terminated by a sponsor because of unplanned cost growth. The

AUTEC Minefield and Shallow Water Range (AMSWR) program was originally established to install a cable from an existing in-water tracking hydrophone array to a shore facility for Commander, US Atlantic Fleet (COMLANTFLT) as the customer. Cabling this array to shore would alleviate the need and expense of mobilizing and operating a range support vessel to conduct underwater tracking exercises at a remote site in the Berry Islands, Bahamas.

In executing to the RSDBU ISO 9001:2000 process, the AMSWR program conducted a combined requirements and technical approach review in August of 2002. The review minutes note that four technical issues were identified and some additional ISO-specific formatting and documentation deficiencies were also noted.[35] The risks identified in the initial phase included ongoing negotiations with the owners of the shore facility where the shore equipment was proposed for location and issues of cost-effectiveness of constructing a permanent building as opposed to using a portable equipment van.[36] These elements were identified as "medium risk."

When the Preliminary Design Review was conducted in July of 2003, the medium risk elements of the program had expanded to include underwater cable installation contract cost overruns or delays and additional cost associated with construction of a permanent building.[37] The post-review comments were primarily focused on accurate documentation of program status within the RSDBU ISO format. Review comments also noted that the program was being executed with "the most mature program management processes [seen to date] within Code 70. The bi-weekly updates of risk assessments and monthly status updates to the program plan are great examples."[38]

Some of the established program risks materialized when the in-water cable installation cost estimates from commercial cable-laying vessel operators increased

---

[35] NUWCDIVNPT, "Code 70 Range Systems Development Business Unit Technical Approach/Program Plan Review Meeting Minutes," 12 August 2002.

[36] Robert J. Reid, "AUTEC Shallow Water Range & Minefield (ASWRM) - ISO 9001 Requirements & Technical Approach Review," Presentation briefing, 12 August 2002, P.12-13.

[37] NUWCDIVNPT, AMSWR Team, Code 70. "AUTEC Minefield & Shallow Water Range (Berry Island Range)," Presentation, 17 July 2003, P. 42.

[38] Debra J. Greenhalgh, "AMSWR ISO PDR Review Updates (Comments)," email to Doris M. Carvalho, 5 August 2003.

significantly over the original estimates, as well as increases in shore facility construction and leasing costs discovered through continued negotiations with owners of the shore facility and the government of the Commonwealth of the Bahamas. The Bahamian government subsequently added additional environmental requirements as a result of evolving national policy initiatives. Also, during the component development and fabrication phase, the Navy found other methods of conducting operations in that area that reduced the need for in-water tracking, effectively lowering the priority for the capability to be provided by the AMSWR program.

The increased costs of system installation, combined with the potential schedule delays associated with the uncertainty of achieving a final agreement with the public and private parties involved, ultimately led to the decision to defer the program indefinitely and reallocate program funding to other priorities. The AMSWR program had complied with the RSDBU ISO 9001:2000 process, but it is unlikely that the totality of the resultant complications that led to the program's termination could have been predicted regardless of the program planning or quality management system in use. The AMSWR system design was of sufficient technical maturity to be considered executable, but the program termination decision was based on multiple contributing factors outside the technical realm. While cost growth was a significant root cause contributor to the final decision, there were also additional legal, environmental and international negotiation complexities that served to induce unacceptable schedule risk in addition to the cost growth issues.

This example illustrates a situation where the RSDBU ISO 9001:2000 process was unlikely to provide a method to identify the major causal factors that led to program termination that were outside the product development and delivery process. The ISO 9000 focus on process conformity tends to emphasize product realization activities in the context of achieving consistent and repeatable processes, enabling requirements trace-ability and improving customer satisfaction. ISO 9000 is not ideally suited for the identification of external environmental or political factors, other than requiring a risk management methodology, to address issues that have the potential to derail overall program execution. Since risk management methodologies are solely at the discretion of

the organization operating within an ISO 9000 quality management system, the results will be proportional to the quality of the specific risk implementation used. In the AMSWR case, the risk management was considered to be comprehensive and proactive, but the program termination decision was based on a combination of individual factors as opposed to one specific risk element.

There is no quality management system in existence that will ensure the success of any undertaking, particularly in complex development environments. In the RSDBU ISO 9001:2000 system, the consistency and repeatability aspects are primarily aimed at program management level tasks as opposed to product realization tasks. This structure is intended to facilitate the accomplishment of customer objectives and maximize customer satisfaction. The AMSWR program team fully complied with the ISO process requirements and the customer was not dissatisfied with the performance of the RSDBU team assigned.

In instances where a customer is dissatisfied, the ISO process provides a defined methodology to resolve customer issues and develop a course of corrective action that is documented, traceable and maintains an appropriate level of visibility at the management level. This portion of the RSDBU quality management system was tested with the Aberdeen Data Acquisition System (ADAS) program.

The Digital Signal Processing (DSP) team of the RSDBU accepted tasking to develop a high-speed digital data acquisition system for the U.S. Army Aberdeen Test Center (ATC) to satisfy a requirement to support ballistic and survivability and lethality measurements. Due to the highly specialized nature of the testing performed at ATC, no commercially-available data acquisition systems were available that would fulfill their requirements. The DSP team undertook the task of developing and integrating a system based on the similarities to acoustic digital signal processing architectures used in under-water tracking range systems and also to support the maintenance of the government's core equity in specialized data acquisition systems.

Since this program was initiated prior to the implementation of the Task Review process, no initial review of the proposal submitted by the DSP team was conducted.

During the course of execution of the program, numerous shortfalls in the program documentation were consistently noted in the design review minutes. In comparison to the AMSWR program, the ADAS team did not employ a mature risk management approach; in fact, risk management was not presented at any of the program reviews although required by the RSDBU ISO process.

As the program progressed, schedule slips, performance shortfalls and cost over-runs occurred due to a number of reasons, including personnel availability, COTS (commercial-off-the-shelf) technology limitations and inadequate requirements specification. Ultimately, this resulted in a complaint from the ATC customer that "product performance, specifically timing and software stability, is not meeting specifications after significant program delay."[39]

In the "pre-ISO 9000" operations of the RSDBU, there was no defined methodology for the handling of customer complaints; this situation would have been handled informally by the Team Leader and Code 70 management depending on the level at which the complaint was lodged. A program review may or may not have been conducted, at the management team's discretion, to assess the situation. The Naval Undersea Warfare Center, Division Newport (NUWCDIVNPT) uses a customer survey process that allows customers to express their satisfaction with the products and services delivered. These surveys are conducted only on an annual solicitation basis, which generally serves to identify a customer's level of satisfaction after-the-fact, thereby significantly reducing opportunities for any necessary corrective action during program execution.

However, under the ISO 9001:2000 quality system of the RSDBU, a defined process exists for handling and resolving customer complaints as laid out in the *Customer Feedback and Complaints* procedure. The specific direction provided states that: "[t]he Team Leader for the project or program evaluates and classifies each complaint, which are [sic] then forwarded to the MR [Code 70 ISO Management Representative].

---

[39] NUWCDIVNPT, Code 70, "ISO 9001:2000 Management Review, Range Systems Development Business Unit Review Meeting," Presentation briefing, 26 March 2004.

Complaints are classified into categories to allow for better tracking of trends and evaluating improvement in specific areas."[40] Based on the Team Leader's evaluation, an appropriate response to the complaint is determined. In cases where the complaint is actionable, courses of action are prescribed by the *Corrective and Preventive Action* procedure. As the procedure name implies, either a corrective action or preventative action is initiated.

The initial course of action prescribed by the *Corrective and Preventive Action* procedure is to determine the root cause of the customer's complaint and develop an appropriate remediation strategy. The root cause of problems can be traced to various levels of the organization, therefore requiring varying approaches to rectification. For example, defective delivered products may be the result of a faulty or insufficient production specification or a flaw in the production system itself. In many instances, production work is subcontracted out and remediation must go through the government contracting process as dictated by the FAR and DFARS regulations. Defective product handling is further specified by another procedure, *Control of Nonconforming Product*, which specifies the methodology for handling and processing nonconforming products.

The ADAS customer complaint was based on performance of prototype system components that had not yet entered production. The RSDBU procedure specifies that: "[t]he Team Leader for the project or program reviews the customer complaint to determine whether it calls for an internal investigation and whether it should be followed up with a formal Corrective Action Request (CAR)."[41] In this case, a CAR was opened and the corrective action required was determined to be the assignment of an expert in digital signal processing and field programmable gate arrays to modify the system design; along with the execution of a strategy to verify that hardware viability for the required application was communicated to the customer.[42]

---

40 NUWCDIVNPT, Code 70, Customer Feedback and Complaints, Doc. No. DBU-QMP-72-01, Rev. 0, 23 March 2004, P. 3.

41 Ibid.

42 "ISO 9001:2000 Management Review, Range Systems Development Business Unit Review Meeting," Presentation briefing, 26 March 2004, P. 13.

Once this remediation action was undertaken, the ADAS program rectified the technical shortfalls noted by the customer and delivered a prototype system for evaluation. The program was deemed complete by the customer and closed out by the RSDBU after the preliminary design review.

As illustrated in the ADAS example, the RSDBU quality management system provided a defined path toward the identification, correction and documentation of customer satisfaction issues. At first glance, the process is somewhat reminiscent of a government regulatory approach, invoking multiple procedures with numerous paths to fulfill the satisfaction requirements of each succeeding procedure; thereby, creating the potential for confusion, time-consuming lost productivity or outright disregard. However, the primary difference in the approach of the RSDBU quality management system is the relative simplicity of the procedures; most procedures are six pages or less and have concisely worded instructions on actions to be taken by the user as well as references to the RSDBU Management Representative for clarification.

Because of the emphasis of the RSDBU ISO 9001:2000 system on program management activities, it is highly dependent on the personnel executing the program to ensure success; ISO 9001:2000 provides only the template. The program review process provides the mechanism to facilitate progress and status visibility at the management and peer level. However, since the program review process is primarily event driven, it is possible for problems to go undetected for significant periods of time. The process requires an in-process review if over one year has passed since the last review. In the authors' opinion, this is a shortfall of the RSDBU ISO 9001:2000 implementation, since programs execute on an annual budget cycle. Therefore, it is possible for a troubled program to go through an entire year without management oversight or peer review, allowing problems to grow in terms of both schedule and budget resources required for correction. A shift to a six-month review cycle, with abbreviated in-process review requirements, might better serve the intended purpose of the program review process.

The previous two examples serve to demonstrate the operation of the RSDBU ISO 9001:2000 quality management system from the perspective of programs that have encountered problems in achieving cost, schedule or performance milestones. They also

serve to demonstrate that the RSDBU ISO 9001:2000 quality management system is flexible enough to accommodate widely divergent program management styles with broadly varying degrees of focus on specific program details, such as risk management. In parallel, 13 other programs operating within the RSDBU ISO 9001:2000 process have completed deliveries or continue to execute within cost, schedule and performance parameters. These programs range in size and duration from $325K one-year efforts to $10.1M five-year development programs and include a broad array of deliverables that range from prototype system designs to complex system development, integration, delivery, and site acceptance.

The AMSWR and ADAS examples also help to illustrate the diversity of the RSDBU business base. In addition to these two programs, other sponsors include the Naval Air Systems Command, the Office of Naval Research, the Office of the Secretary of Defense, Director of Operational Test and Evaluation (DOT&E), the NAVSEA Test and Evaluation Office and the Army Program Manager for Instrumentation, Targets and Threat Simulators (PM-ITTS). As would be expected, program management styles and requirements vary significantly across this group.

Therefore, the resultant ISO 9001:2000 implementation was developed by necessity to target the lowest common denominator of program management requirements, focusing on requirements traceability, product realization and customer satisfaction as the minimum set of requirements for all programs. To have gone into a greater level of specific process implementation would only have served to make the process unwieldy and less applicable to some components of the business base and would likely have eroded the support and endorsement of the RSDBU users. Ultimately, program success cannot be attributed to the RSDBU ISO 9001:2000 process any more than program failure; the quality management system provides only a tool for management to evaluate progress and status. Consequently, the effects of the RSDBU quality management system on overall organizational performance will be determined by the effectiveness with which the quality system is used by senior management to monitor and influence program development and execution.

D. ISO 9001:2000 AND SMALL UNIT PRODUCTION ACTIVITIES

With few exceptions, the RSDBU has executed and continues to execute programs that have a unit production quantity of one delivered end product or system. This is primarily driven by two factors: the size and complexity of the underwater range systems and the small number of underwater ranges both domestically and globally.

Currently, the U.S. Navy operates four major underwater tracking ranges in or near U.S. waters, and there are several other small-scale, special-purpose underwater measurement installations also in existence. The in-water sensor system components of underwater ranges are generally designed for a 20-year life expectancy due to the significant expense associated with the specialized equipment and ships required for in-water equipment installation. These costs serve as a deterrent to repair of failed in-water system components since it quickly becomes more cost-effective to simply replace a failed component as opposed to the costs and time required for retrieval, diagnosis and correction.

Automated Data Processing (ADP) components of underwater range installations have shorter life spans due to the rapid pace of advancement in the commercial ADP equipment sector. However, due to the continually tight fiscal constraints of the DoD operating environment, range ADP equipment is often not replaced until it is past obsolescence and no longer economically feasible to repair or maintain. For example, the major ADP system components at the AUTEC range were last replaced in 1995 and the ongoing replacement program is a five-year, $6M effort due to the requirement to fundamentally re-architect the whole system because of the leap-forward in technology implementation. This program will complete in 2006, making it 11 years (or viewed another way: at least three generations of computing technology) between major ADP technology upgrades for the AUTEC range.

Given the limited frequency with which these types of programs occur, it is difficult to define a consistent program execution process that will remain relevant because of the major changes in industry and technology that occur during the periods between similar major programs. The net effect is that no two programs will ever be executed the same way. As a result, the RSDBU ISO 9001:2000 quality management

system must be, and has been, structured to accommodate the advances of technology and evolving requirements of programs with small unit production quantities.

The two key characteristics enabling ISO 9001:2000 to be used effectively in the low unit production environment of the RSDBU can best be described as tailoring and generality. These characteristics support the approach to ISO 9001:2000 implementation that "[t]he complexity and interaction of processes and the competence of the personnel determine the scope of the documented system."[43]

Tailoring allows procedures and work instructions to be developed to the appropriate level of detail based on the functions of the organization and the complexity of the tasks undertaken. For example, a principal emphasis for the RSDBU quality system is the standardization of general program management processes and system engineering practices across the business unit. Thus, the majority of the effort in procedure development was devoted to the *Design Control Process*, resulting in an 83-page set of procedures as compared to the average of six pages each for most other RSDBU procedures.

The *Design Control Process* was developed based on a combination of current program management and system engineering practices that have been effective in executing RSDBU programs and augmented by the EIA 632 standard. The *Design Control Process* does not focus on the production quantity of the program and is intended to ensure that system designs maximize the achievement of customer performance objectives within cost and schedule constraints. In this context, the portion of the *Design Control Process* dealing with system production and implementation does not specifically address production issues that would normally be associated with large-volume production programs, such as specialized tooling or manufacturing spaces, because those are not significant considerations for programs executed by the RSDBU. The guidance of section 17.2.5 simply states, "buy it, build it, integrate it,"[44] thereby leaving the specifics of production methodology to the program team.

---

43 NUWCDIVNPT, Code 70, Summary of Range Systems Development Business Unit (RSDBU), Department Business Unit And Cost Center(s) (DBU) Level II Document, 2 June 2004, P. 1.

44 Design Control," Doc. No. RSD-QMP-73-01, Rev. 3, 24 February 2004, P. 74.

The generality aspect of ISO 9001:2000 provides the flexibility to target processes at the appropriate level of the organization based on the overall competence level of the workforce involved in program execution. Members of the RSDBU, with very few exceptions, possess a minimum of an undergraduate degree in a technical discipline, primarily engineering and computer science. They have also been trained and certified to Defense Acquisition Workforce Improvement Act (DAWIA) standards to meet the requirements of NUWC Division Newport policy objectives. All of the RSDBU Team Leaders have been certified to DAWIA Level III for Systems Planning, Research, Development and Engineering. For these reasons, it is safe to assume a baseline level of employee competence in systems development and realization activities that alleviate the necessity to define RSDBU work instructions and procedures to overly detailed levels of specificity.

In large-volume production activities for which ISO 9000 was initially conceived, it is highly probable that a more diverse skill mix of employees would be involved, such as would be found in a manufacturing setting in industry. If the ISO 9001 standard mandated a total level of process documentation structured for the minimum level of competence in an organization, work instruction and procedure generation would quickly become burdensome, inefficient and costly. However, since the standards and interpretations of ISO 9001 registrars compensate for the level of competence in an organization, documentation content and effort can be appropriately scoped.

To date, the fact that RSDBU programs produce limited quantities of delivered products has not been a significant factor in the overall effectiveness of the ISO 9001:2000 implementation. The system production aspect of the *Design Control Process* has been targeted toward the final integration, testing, installation and site acceptance tasks that are necessary for the types of systems produced. The business base of the RSDBU makes it difficult to compare one program to another, but the structure of the RSDBU quality management system facilitates the identification of those program phases that present the greatest challenges or offer the greatest success. The ISO 9001:2000 approach allows the RSDBU, as consumers of the standard, the flexibility to bypass those

elements associated with large volume production and tailor processes to maximize value to the members and customers of the RSDBU, regardless of the production quantity.

As discussed herein, the RSDBU implementation of ISO 9001:2000 has proven beneficial to the organization by providing a measurement and management tool that has been tailored to the overall focus of the RSDBU business base. By definition, the system cannot be optimized for every program and customer due to the diversity of the business base that drives the necessary generality of the quality management system. Nonetheless, the initial investment in a quality management system can often be daunting for an organization depending on the scope of the processes involved, especially since it is difficult to specifically quantify the actual business performance gains achievable from the system. This aspect will be discussed in more detail in Chapter III.

THIS PAGE INTENTIONALLY LEFT BLANK

III. ISO 9001 IN THE DEFENSE ACQUISITION WORKFORCE

A. INTRODUCTION

The purpose of this chapter is to analyze the use of ISO 9001:2000 in the broader Defense Acquisition Workforce and explore similarities and differences in the application of ISO 9001 between the RSDBU and other organizations, both government and commercial.

B. ADVANTAGES AND DISADVANTAGES OF USING ISO 9001 TODAY

The quality management community has given significant attention to the pros and cons of ISO 9000 certification as the number of certified organizations has grown significantly over recent years. Numerous studies of the effects of ISO 9000 certification have been conducted to determine if there is a direct and traceable link from certification to business benefits. These studies primarily seek to compare the actual results of ISO 9000 certification in contrast to the expected benefits cited by organizations when the decision was made to pursue certification.

Proponents of ISO certification extol the benefits that increased quality has on business performance based on the assertion that an ISO 9000 certified quality management system directly contributes to increased quality of the end product or service delivered. Critics of the ISO 9000 approach dispute the correlation between ISO certification and product quality as being significantly more complex than simply having a certified quality management system. They contend that it is possible to have an adequately documented set of processes that produce well-documented bad results, such as the oft-cited example of a very efficient producer of concrete life jackets.[45]

Similarly, the pursuit of certification because it is required by customers (sometimes referred to as "marketplace coercion") has been the subject of much debate and criticism by some quality management analysts. They generally contend that the benefits of certification are inflated by many ISO 9000 registrars and consultants who earn their

---

[45] DiverDiver, e-government@large, "e-Government@large, 2004 Is The Year It All Goes Mainstream," 24 September 2002, http://www.diverdiver.com/2002_09_25_diverdiver_archive.html, Accessed April 20, 2004.

living from the ISO process and that there is a wide degree of variability in quality amongst ISO 9000 certified companies.

Organizations that claim benefits of certification include the International Standards Organization (ISO), the American Registrar Accreditation Board, the National Quality Assurance certification body of the UK and the British Standards Institute. While the ISO makes no explicit claims past the fact that "organizations that implement ISO 9000 voluntarily are doing so because they expect these standards to help them do things better and to provide real benefit,"[46] the certification and registrar communities go a step further. Claims that certified quality management systems can "[l]ower costs through reduced wastage and quality improvement"[47] and provide "increased market share through perceived higher quality and/or improved market opportunities"[48] are frequent in literature and promotional materials developed by these organizations.

An example of this situation can be found in material from Vinca, LLC, who are providers of ISO 9000 certification resource materials. They cite a case study published in the Dallas Business Journal crediting ISO 9000 certification with increased productivity, reduced scrap and waste, record sales levels and better incoming raw material screening.[49] What they fail to clarify is that this case study is based on the experience of only one company with two-dozen employees. This sort of generalization serves to reinforce the contention that the benefits of ISO certification may be artificially inflated by some organizations that have a vested interest in promoting ISO 9000.

The British Standards Institute has been somewhat more rigorous with case studies of companies in the service, manufacturing or raw materials processing sectors.[50] A review of 18 of these studies revealed that 17 companies claimed increased customer satisfaction, 13 improved internal operations, 12 saw improved product quality, nine

---

46 Gavin P. M. Dick, "Certification Benefits, Reality or Myth?," *ISO 9000, The TQM Magazine*, Vol. 12, Issue 6, 2000, ISSN 0954-478X, P. 2, http://konstanza.emeraldinsight.com/vl=3310045/cl=42/nw=1/rpsv/tqm.htm, Accessed April 20, 2004.

47 Ibid.

48 Ibid.

49 Cynthia Weber, Quest Analytical, Inc., "Benefits of ISO 9000…," Presentation, 15 March 2004, http://www.the9000store.com/benefits_of_iso.ppt, Accessed April 23, 2004.

50 BSI Management Systems, "Case Study List," http://emea.bsi-global.com/Quality/CaseStudies/CaseStudyList.xalter, Accessed April 23, 2004.

reduced costs, and eight increased profits.[51] The businesses surveyed included financial services, utilities/energy, property management, marketing, transportation, construction and telecommunications companies with a range from 100 to 71,000 employees. Interestingly, amongst the above claims of improved business results, at least half of the companies surveyed cited customer pressure or explicit customer requirements for ISO 9000 as one of the motivations to pursue certification, lending credence to those that claim "marketplace coercion" as a major driver in increased ISO 9000 registrations.

The vast majority of study material generated by commercial organizations focuses on industry applications of ISO 9000, since that is currently the major market for consultants and registrars. As can be seen by the examples cited above, it is possible to interpret study data in a manner consistent with the goals of the organization using the data. The Vinca, LLC, use of a single case study is presented in a far more generalized fashion without noting the limited sample upon which the conclusions are based is one example. Similarly, the BSI cases concentrate on businesses that generally have well-defined procedures due to regulatory and/or business requirements and are primarily focused on a single business area. However, their results do not reflect a strict attribution of the contribution of ISO 9000 to the results but are solely a "before and after" comparison.

From the academic perspective, a paper written by Gavin P.M. Dick, a Senior Lecturer at Staffordshire University Business School, contends that a proven correlation exists between quality and business performance, including sales growth, financial returns and overall company performance.[52] However, in Dick's opinion, the research evidence does not support a link between improved business performance and ISO 9000 certification. He found that an important indicator of business performance gains achieved by certification is the motivation that initially led to the pursuit of certification.

"Companies that cited customer pressure as their reason for pursuing certification were less likely to report improvements than those which gave other reasons for adopting

---

[51] BSI case studies summary, Richard Lutman, McLaughlin Research Corporation, May 2004.
[52] Gavin P. M. Dick, P. 2.

QCert"[53] (a certified quality management system). This was echoed in the Dallas Business News case cited previously when the president of the company commented on the pursuit of ISO certification as a sales and marketing tool: "It's only a marketing tool until everyone has it… for companies who do it wrong it's a bunch of baloney."[54] Since at least half of the companies in the BSI case study cited some form of customer or market pressure as a motivating factor, "marketplace coercion" is as significant a factor as the desire to improve for many companies implementing ISO 9000.

Vanguard Education, a United Kingdom-based company that markets educational products for the application of systems thinking to improve organizational performance,[55] goes a step further with their opinion of ISO 9000 certification: "registration to ISO 9000 should be avoided."[56] They assert that the use of ISO 9000 generates a mindset of rigid process conformity as opposed to a true focus on product quality, process improvement and innovation. However, they do not ignore the fact that ISO 9000 is expanding as a requirement to do business in many sectors and offer the Vanguard Standards for "systems thinking" as an alternative quality system. The Vanguard Standards are an extension of ISO 9000 and were developed as a tool for learning and improvement, as opposed to strict conformity, that enables achievement of ISO 9000 certification with increased emphasis on product quality and customer value.

From the foregoing discussion, it is possible to conclude that ISO 9000 certification can provide improved business performance if used in the proper perspective: as a management tool supported by the appropriate level of management commitment to improve corporate quality. The main difference between ISO 9000 and other quality management systems is the fact that many companies and government agencies, both domestic and international, are requiring ISO 9000 certification of their suppliers. This

---

53 Ibid.

54 Margaret Allen, "Polyguard Bolsters Quality, Productivity with ISO 9000 System Sysprocess," *Dallas Business Journal*, 15 August 1997 [journal on-line], P. 4, Available at http://www.bizjournals.com/dallas/stories/1997/08/18/smallb1.html, Accessed April 23, 2004.

55 Vanguard Educational Website, http://www.lean-service.com/sub2.asp, Updated 10 November 2003.

56 "The Vanguard Standards: A systems thinkers guide to interpretation and use of ISO 9000:2000," P. 2. http://www.lean-service.com/3-1.asp, Accessed April 23, 2004.

trend provides an advantage for using ISO 9000 as opposed to other quality systems since it serves to maximize the customer base of an organization.

A commonly cited disadvantage of using ISO 9000 is the cost and time requirements associated with defining, documenting and maintaining an organization's quality policy, procedures and work instructions.[57] The commitment of overhead resources and allocation of management time necessary to adequately define the processes of a business unit can represent a significant up-front cost. In the authors' opinion, the expense of ISO 9000 certification results in a largely unquantifiable return-on-investment for organizations such as the government that do not have an economically quantifiable business process.

To validate this assertion, it is necessary to define an "economically quantifiable business process" for this context. Since ISO 9000 originated in the manufacturing sector, we will begin with that perspective. For a manufacturer, the organization's business processes generally center on the transformation of incoming material to a refined end product for a number of identical end-items. Each step of an effective process will be definable and therefore lends itself to quantifiable measurement. Use of a variety of analysis tools, such as statistical process control, can provide detailed insight into the internal operations of the process and, in so doing, facilitate an assessment of the efficiencies of process components. Assessment of process components is then used to optimize the overall efficiency of the organization's end-to-end process.

For an organization considering ISO 9000 implementation, the availability of process analysis data can significantly contribute to the initial cost-benefit analysis to quantify the expense of certification with respect to the benefits to be gained. Estimations in overall process improvement can be directly translated into a financial frame of reference, providing decision makers with an objective measurement of the

---

[57] The Business Link — Business Service Center, "What is ISO 9000?" http://www.cbsc.org/alberta/tbl.cfm?fn=iso, Updated 11 March 2003, Accessed April 23, 2004.

returns expected from the investment in an ISO 9000 quality management system. Since most corporate analysis tools operate within the financial domain, these assessments work well within that context.

However, process analysis tools depend on a large number of samples to establish statistical significance and thereby provide a reliable measure of effectiveness for changes to organizational processes. For most government activities, this metric is not valid since governments do not normally engage in manufacturing-like enterprises; those activities are contracted to private industry. An exception to this observation can be found in operations such as military depots, where items are refurbished using a repetitive process that lends itself to process analysis. However, the current trend is to outsource this type of work to industry wherever it is economically advantageous.

Most government activities operate in a more ambiguous environment where organizational inputs and outputs are not often directly traceable through defined and consistent processes. Even those activities that have a defined process may have a high degree of variability in each sample. For example, the processing of income tax returns by the Internal Revenue Service (IRS) has a defined and structured process. However, because of the complexity and dynamic nature of tax laws, it would be difficult to derive a statistically valid assessment of the efficiencies of that process. The same argument could be made for the processing of Social Security claims or veterans' benefits, since each example operates in a complex statutory and policy environment serving individual needs.

Similarly, the processes in a U.S. government military research and development organization have a high degree of variability resulting from the inherently unpredictable nature of research and development and dynamic requirements of the current military threat environment. For example, attempting to apply statistical process measurement tools to the development of a piece of technology, such as a digital signal processor, for different applications would have little value because of the variability of the requirements and operating environment for each application. Statistical tools could be applied to the production of multiple units of a single design with a high degree of effectiveness, but this function would normally be contracted to industry.

The foregoing analysis draws to a fundamental difference between public and private sector enterprises: the repeatability, and therefore profitability, of the organization's processes as a function of the business base. For instance, the RSDBU is retained as a government enterprise because the business base is highly variable and unpredictable, thereby making it unprofitable for industry to maintain a robust base of available providers. The variability of the business base leads to organizational processes that cannot be reliably statistically quantified, which serves as a disincentive for industry to engage in this function. Thus, the majority of government activity in general, and military research and development specifically, falls into a business area that is not economically quantifiable.

Hence, the impact of a documented quality management system on the organizational output of a government enterprise will be difficult to reliably predict prior to making the investment due to the limitations of statistical process measurement for government functions. Accurately measuring the impact of a quality system on a government organization's performance metrics can be equally difficult once it has been established for this same reason. Gross measures may be derived based on "before and after" comparisons, but attributing detailed numerical quantities such as a reduction in operational costs or a decrease in cycle time to the predicted performance of a quality system would have a highly subjective interpretation.

Corporate and government cost-benefit methodologies are generally geared to the realm of capital purchase decisions based on assumptions of increased productivity and/or reduced costs associated with an investment. Analysis methodologies, including net present value, internal rate of return, payback period, least cost and similar approaches,[58] rely on numerical quantifications of expected outcomes and can provide significant value in framing a decision. However, these approaches should be used with extreme caution when evaluating investment in a quality management system because of the prevalence of the human element in realizing gains from implementation. Estimating

---

58 Naval Postgraduate School of Business and Public Policy, Course material from MN3155, Financial Management for Acquisition Managers, Winter Qrtr 2000, P. 20-30

the gains to be achieved before implementing the system is at best a "what if" scenario process of correlating potential gains to a payback period for process documentation and certification costs.

Based on the assumption that most cost-benefit analyses for ISO 9000 implementation for a government organization will be of limited utility, how does ISO 9000 offer an advantage? Perhaps the best answer to this question is found in the fact that an organization that goes through an ISO 9000 process documentation initiative is forced to examine all of the internal business process steps required to transform organizational inputs to organizational outputs. An effective management team will use the opportunity to examine organizational process in search of *muda*, or waste, using the same philosophy as Japanese lean producers[59] that seek to eliminate anything that does not directly add value to the end product.

ISO 9000 registration efforts may be used as an opportunity to evaluate and optimize processes as opposed to simply documenting the existing ways of doing business. Those parts of organizational processes that do not add value to the final output should be eliminated; to do otherwise is simply the act of documenting a suboptimal process. While this forced introspection could be accomplished without the use of ISO 9000, the standard provides a useful framework to ensure that a comprehensive examination is conducted.

The use of ISO 9000 also suffers from the lack of a centralized registration recording structure. According to the disclaimer on the ISO organization website: "there is no 'official central database' of ISO 9001 or ISO 14001 certificates and ISO does not hold lists of names or any information about certified organizations."[60] The structure of the ISO certification process is such that independent registrars are the only bodies that issue certificates. Therefore, statistics on certifications can be difficult to track, since

---

59 Nick Rich, "An Executive Guide to Lean Thinking," Deloitte & Touche Senior Executive Series of Briefing Papers [Deloitte & Touche Senior Research Fellow Lean Organisation Research Centre, Cardiff Business School], P. 5-6, http://www.deloitte.com/dtt/cda/doc/content/lean_briefing(1)(1).pdf. Modified 6 June 2002, , Accessed April 23, 2004.

60 International Organization for Standardization, "Statistics on certifications worldwide," 1st para., http://www.iso.ch/iso/en/xsite/contact/01enquiryservice/011ISO9000/certification/stats.html, Modified 8 March 2004, Accessed April 23, 2004.

registrars appear to have different styles when it comes to providing certification information. This is exemplified by the apparently differing applications of the Standard Industrial Classification (SIC) codes applied to ISO certified organizations.

The SIC system of the U.S. Department of Labor Occupational Safety and Health Administration[61] serves as the basis for categorizing the type of business in which an organization primarily participates. There is a separate British SIC system used by many U.K. registrars that does not directly correlate to the U.S. system. Also, no categorization of ISO registrants exists on the basis of being a public versus a government organization, although there is a section of the SIC codes devoted to "Public Administration" where one could reasonably expect to find government organizations.

An analysis of the 10 ISO 9001 registered U.S. Navy organizations, as recorded in the *Quality Digest* magazine ISO 9000 database,[62] reveals that they are classified across numerous SIC codes, including subcategories of manufacturing, services, transportation, electric, gas and sanitary services and even wholesale/retail trades. While some of this may be due to differing registrar approaches, the disclaimer on the database also notes: "[w]e have found that industry classification codes are often input incorrectly."[63] Perhaps this is an area where the ISO registrars and standards development bodies could apply some of their own wisdom. The development of standardized processes for recording certification data in a common repository using consistent reference styles could significantly improve conformity. The composition of the *Quality Digest* ISO database appears to have a notable lack of conformity in terms of level of detail as well as classification of entries.

In summary, ISO 9000 offers a defined methodology of process documentation that may be used for organizational performance improvement if applied correctly. However, ISO 9000 can initially be an expensive proposition because of the scope of the effort involved in process documentation, and may be difficult to financially justify from

---

61 U.S. Department of Labor, Standard Industrial Classification (SIC) System Search, http://www.osha.gov/pls/imis/sicsearch.html, Accessed April 23, 2004.

62 Quality Digest, ISO 9000 Database, http://www.qualitydigest.com/iso9000database.shtml, Accessed May 22, 2004.

63 Ibid.

a return-on-investment perspective unless a rigorous cost analysis system is already in place and functioning efficiently. If a cost-benefit justification is necessary, the business of the organization should also be such that "before and after" comparisons are realistic and based on consistently measurable quantities. Cost benefit analyses should also reflect that once the initial certification is achieved, resources must be devoted to maintaining and improving the quality system.

Therefore, ISO 9000 may not be a significantly better management tool than many of the other quality management schemas that are widely available, but ISO 9000 comes with the added benefit of international recognition that allows an organization to maximize its customer base. If a management team is truly motivated to improve organizational performance, ISO 9000 can be a valuable tool to assess the complete process. However, the final decision on a quality management system should be based on the compatibility of the tool to the organization's goals and operating methodologies, combined with the demands of the market in which the organization operates. If "market coercion" is a factor, that should be understood, but ISO 9000 will provide the most benefit if it is used as a tool to improve organizational performance, as opposed to a minimalist approach intended primarily to mollify customers.

C. SIMILARITIES AND DIFFERENCES BETWEEN ISO APPLICATIONS

ISO 9000 provides a standardized approach for the establishment of a quality management system that can be used across virtually any organization. However, as previously discussed, cost-benefit analyses to justify the initial investment may not be reliable; an organization may, nevertheless, proceed with ISO certification efforts, based on a rational desire to improve performance, using ISO 9000 as an organizational analysis tool.

From the RSDBU perspective, it is impossible to definitively quantify the value of the ISO 9001:2000 Quality Management System (QMS) implemented based on objectively measurable criteria such as financial performance or product quality measurements. Due to the wide variance amongst RSDBU programs conducted both historically and at any given time, an objective "before and after" analysis is not realistic.

Returning to the primary motivations for RSDBU quality management certification demonstrates that these goals are difficult to measure objectively:

- Instill discipline in planning and cost estimates
- Better understanding of technical work being performed across the organization
- Ability to bid on FMS work requiring ISO 9000 certification
- Documentation of lessons learned

Even for those items for which an objective measure can be devised, the assignment of the proportion of the measured result that is attributable to ISO 9000 certification will always be debatable in any analysis. To expand on this point, a cursory review of possible analysis methods to prove that the Code 70 objectives for the RSDBU have been met will illustrate the difficulty of deriving a quantifiable return on investment:

Instill discipline in planning and cost estimates: This aspect could be measured by the number of programs that achieve cost, performance, and schedule benchmarks versus those that do not or through trend analysis of RSDBU program execution performance. However, as illustrated in the AMSWR and ADAS examples of Chapter 2, ISO 9000 has varying degrees of effectiveness on program performance issues that cannot be specifically attributed to the influence of a quality management system.

Better understanding of technical work being performed across the organization: "understanding" is a nebulous term to measure without applying some form of academic rigor, which in this case would be complex and of limited utility. Subjective and primarily anecdotal estimation would be the primary measurement method.

Ability to bid on FMS work requiring ISO 9000 certification: With the achievement of ISO 9000 certification, the RSDBU attained *the ability* to bid on FMS work requiring ISO 9000 certified offerors, so in that context the RSDBU quality management system could be considered to have met the desired objective. However, since certification, the RSDBU has not actually gained any FMS work, which could be inter-

preted as a failure of the system implemented, but is more likely due to the vagaries of FMS work volume. However, due to the inherent complexities of the FMS market, an attempt to allocate success or failure to either assertion would be of no value.

Documentation of lessons learned: The RSDBU quality management system does not provide a defined methodology for documenting lessons learned other than mandating consistent program documentation and review requirements and continuous improvement initiatives. Eventually it may be possible to derive an estimate of cost avoidance if documentation of a previous program proves to be useful in the conduct of future business, but the actual dollar value would ultimately be a highly subjective estimate.

These examples illustrate what, in the authors' opinion, is the biggest disadvantage of using ISO 9000 for an organization such as the RSDBU: the inability to objectively measure and quantify the benefits of a documented quality management system. In a commercial manufacturing setting, statistical production metrics can be compared in a 'before and after' context to determine if defect rates, station cycle times or other easily quantifiable measurements have changed. Those reductions can be translated into approximate dollar values, and, therefore, a quantified change in performance can be described. For the RSDBU, this is not possible because the broad variation and low quantity of output products invalidates statistical significance.

This aspect makes it difficult to justify the initial expense of process documentation and equally as hard to justify the continued expense of process maintenance for organizations such as the RSDBU. Whether the product is program management, system engineering services or actual hardware and software deliverables, the fact that each task differs significantly from either previous or ongoing tasks effectively eliminates an objectively analytical basis for comparison. It is counterproductive to attempt to quantitatively assess the benefits of certification from a cost analysis perspective by comparing a "pre-ISO" and "post-ISO" RSDBU program. This forces an organization whose

members are almost exclusively engineers and scientists to accept a subjective assessment of certification benefits, which tends to be inconsistent with the organizational culture.

Other government organizations have applied the ISO 9001 in manners both similar to and different from the RSDBU. The 10 ISO 9001 registered U.S. Navy organizations as recorded in the *Quality Digest* magazine ISO 9000 database comprise both logistics-focused organizations as well as RDT&E activities. Navy ISO 9001 registrations (including both 1994 and 2000 versions) include naval aviation depots, the Naval Medical Education and Training Command and components of the Naval Surface Warfare Center and Naval Undersea Warfare Center.[64] The scope of their certifications includes:

- Aircraft maintenance, repair, overhaul, and modification services
- Technical library services
- Healthcare acquisition and logistics support to Navy medical and dental units
- Design and development of training films, graphics, and curriculum for the Naval Health System worldwide
- Aircraft support services (paint & flight test)
- Engineering, logistics, maintenance, and program management for electronics, electronic warfare, and ordnance
- Hardware and software design, engineering, parts procurement, production, integration, check out, test, of the AN/UPX-36 (V)6 IFF System
- Acquisition program support
- Engineering of polymers, composites, metals and ceramics

---

64 Ibid., 16 May 2004.

- Nondestructive evaluation
- Corrosion and materials protection technologies and materials engineering
- Laboratory testing services for calibration and verification
- Research and development, test and evaluation, fleet support, test facilities, and in-service engineering for surface and undersea vehicle hull, mechanical, and electrical systems and propulsions, and logistics research and development
- Design services for and provision of maintenance and repair services
- Design, development, integration, testing and installation of undersea warfare training, test and evaluation systems[65]

This list demonstrates that the Navy business units that have become certified differ in focus, from narrowly defined areas such as aircraft logistics support, to more broadly scoped areas of research and development for a class of systems. In these instances, ISO 9001 was applied at an activity or organizational level with a reasonably well-defined focus that allows a consistency of processes that facilitates the achievement of the organization's mission. The flexibility of the ISO 9001:2000 standard is the primary characteristic that enables organizations operating within this spectrum of specialization to be certified under a common system.

As shown above, U.S. Navy organizations implemented ISO 9001 in order to achieve better cost efficiency and quality performance within a fairly narrowly defined scope of endeavor. For example, naval aviation depots perform a defined and consistent scope of tasks in the process of refurbishing aircraft. ISO 9001 offers a method of standardized process documentation that facilitates maximizing the efficiency of these organizations as well as providing a "brand name" quality system that may also provide advantages during the conduct of outsourcing (A-76) studies to fulfill quality assurance requirements as well as BRAC (Base Realignment and Closure) analyses.

---

[65] Ibid.

As discussed in earlier chapters, NUWC Division Newport, as a Navy Working Capital Fund activity, has a different incentive base than mission-funded Navy ISO 9000 certified organizations: to remain viable based on continued customer funding. ISO 9001:2000 certification for the RSDBU was perceived as a tool that would enable the RSDBU to better support a business base that retains the core equity of undersea range development while simultaneously contributing to the attainment of NWCF financial goals. Process standardization can contribute to meeting these objectives by improving internal processes to maximize value to the customer and thereby increase the likelihood of maintaining or improving the business base. However, because process standardization was not a broadly-based organizational imperative, the approach used was selective certification of an individual business unit.

In contrast, an organization such as the National Aeronautics and Space Administration (NASA) chose to approach ISO 9000 certification for the entire enterprise, including its headquarters and 11 research and development centers. In a 1996 letter to Officials-in-Charge of Headquarters Offices, Directors of NASA Field Installations, and the Director of the Jet Propulsion Laboratory (JPL), NASA Administrator Daniel S. Goldin wrote, "We are leaders in the world of science and technology. We must also be leaders in the world of quality. To this end, I am requiring that the Agency be third-party certified in our key processes, by an internationally recognized registrar, to ISO 9001. This commitment applies to all Centers and Headquarters."[66]

NASA operates under a different set of incentives than a Defense Working Capital Fund activity and, consequently, had differing motivations from the RSDBU and thereby chose a different path to certification. The level of public and congressional visibility received by NASA quality issues was likely the greatest single motivating factor in the institution of an enterprise-wide quality management system. The

66 Frederick D. Gregory, Associate Administrator for Safety and Mission Assurance [signatory], NASA Headquarters, "Program Commitment Agreement, NASA Registration to the United States Version of the International Organization for Standardization's 9000 Series Standard," 9 July 1999, http://www.hq.nasa.gov/office/codeq/doctree/isopca.pdf, Accessed May 22, 2004.

enterprise-wide approach also serves to deflect any public or political scrutiny that any part of NASA would receive had it been exempted from the certification effort.

However, the NASA ISO 9001 certification effort apparently has not been completely successful in fulfilling organizational quality objectives since the completion of certification of all sites on September 24, 1999.[67] Fredrick Gregory, NASA Deputy Administrator, wrote in a December 12, 2002 letter: "[r]ecent experience, as expressed in Freedom to Manage (F2M) inputs from several Centers and Headquarters Offices, indicates that ISO 9001 may not be the only or the best tool for every situation."[68] On April 17, 2003, NASA changed their Management System Policy[69] to remove the ISO 9001 certification as a mandate, substituting their own internally developed set of standards. NASA Policy Directive (NPD) 1280.1 is intended to:

> …provide Center Directors with both the responsibility and flexibility to implement management systems commensurate with the risks associated with the activities under their care. We anticipate that most Centers will retain ISO 9001 as their means of complying with this new NPD. However, Centers will have freedom to experiment with or move to other systems, as long as the same minimum standards are met, such as third party validation.[70]

This change in policy could lead to the conclusion that ISO 9001 may not be a single point solution for all organizations, particularly large public enterprises with complex organizational missions. Even with the inherent flexibility of the ISO 9001 standard, its implementation must be consistent with the requirements of the organization to ensure it functions as an effective management tool.

The foregoing comparison illustrates the opposite extreme of ISO 9001 application from the RSDBU where ISO 9001 was applied at the enterprise level. The

---

[67] Sonja Alexander, "NASA Achieves ISO 9001 Registration at All Sites," 24 September 1999, http://articles.findarticles.com/p/articles/mi_pasa/is_/ai_366684083, Accessed May 22, 2004.

[68] AD/Deputy Administrator, "ISO 9001 and Beyond" [letter], To Officials-in-Charge of Headquarters Offices Directors, NASA Centers, 12 December 2002, P. 1, http://www.hq.nasa.gov/iso/12_02_gregory.doc, Accessed May 22, 2004.

[69] NASA Quality Management Systems, "Welcome to the Agency Quality Management System Page!," para. 1, http://www.hq.nasa.gov/iso/, Accessed May 22, 2004.

[70] AD/Deputy Administrator, "ISO 9001 and Beyond" [letter], 12 December 2002, P. 1, http://www.hq.nasa.gov/iso/12_02_gregory.doc, Accessed May 22, 2004.

previously discussed Navy implementations represent a middle ground where ISO 9001 was applied at the activity level for organizations, such as naval aviation depots, that have more specifically defined organizational functions. The NASA retreat from an ISO 9001 certification approach for the total organization reveals that ISO can become unwieldy and less effective if the scope of the certification is expanded across a very broad field of endeavor, such as space flight. While the RSDBU approach may be considered a "micro application" of ISO 9001 in comparison, it demonstrates that this approach is likely the best for organizations that do not have clear cultural or environmental drivers that justify the time and expense associated with a large-scale certification effort.

D. EFFECTS ON COMPETITIVE ADVANTAGE FOR THE RSDBU

To analyze this question, it is necessary to first define "competitive advantage" within the context of the RSDBU and its parent organization, the Naval Undersea Warfare Center. The ongoing realignment of the NAVSEA warfare centers that includes the six divisions of the Naval Surface Warfare Center and the two NUWC divisions is intended to create an environment which is non-competitive. The NSWC and NUWC organizations providing the core equities necessary to support the NAVSEA mission are defined as unique national assets that are not duplicated in industry and are required to preserve national military capabilities. The NAVSEA realignment is intended to provide a structure that identifies and adjusts the workforce and associated physical infrastructure necessary to efficiently support these core equities within the context of Navy strategic planning, which is currently embodied in the CNO's Sea Power 21 vision.[71]

However, at the activity level, the primary measure of effectiveness remains Net Operating Result (NOR), based on the annual financial performance of the organization. NOR is the public organization equivalent of the profit/loss metric used in commercial industry; the main difference being that a government organization does not seek to make a profit, but balance income with expenses thereby ideally achieving a NOR of zero. The NOR metric is driven by the fact that the NAVSEA field activities operate in the NWCF construct that is intended to identify the relative efficiencies of organizations. Activities

---

71 NUWCDIVNPT, NUWC Concept of Operations (CONOPS), 25 January 2004, P. 2.

generating a negative NOR, which is effectively a "loss," can be classified as either inefficient or having overcapacity for the current needs of the NAVSEA mission.

Within this external operating environment, the NAVSEA realignment process, combined with the NWCF constraints, incentivizes organizations to demonstrate their value-added through both technical proficiency and business efficiencies. This is reflected by one of the many duties of the NUWC Technical Director (TD), who has a responsibility to "ensure that a robust technical capability is maintained within the Navy without duplication and/or competing capabilities."[72] An additional duty of the TD is "to ensure that NUWC's workforce is balanced with the Navy's workload,"[73] which implies both expanding the workforce where additional capacity is required, or reducing or realigning the existing workforce where overcapacity is identified.

Nonetheless, a "competitive advantage" within this context represents an organization's ability to demonstrate that it is technically proficient and economically efficient in the performance of its mission in support of NAVSEA objectives, whether duplication exists or not. If there is duplication in the form of internal overcapacity at the warfare center level or external overcapacity at the NAVSEA corporate level, senior leadership will determine how each issue is resolved using a defined methodology for work assignment. Since this methodology is structured to align the workforce along roles and missions of each organization, an ISO 9001 certified quality system will not be an attribute evaluated in the decision process.

However, it is incumbent on each organization to optimize their operations to maximize quality and efficiency as a mandate of public service. In the case of the RSDBU, having an ISO 9001:2000 certified quality system is one method to demonstrate a commitment to both quality and efficiency. The quality system serves as both an organizational credential and a methodology to provide greater transparency to RSDBU customers into how their projects will be executed.

---

72 Ibid., P. 30.
73 Ibid., P. 1.

The preceding analysis demonstrates that an ISO 9001:2000 certified quality management system does not serve to provide a competitive advantage to the RSDBU within the context of their operating environment, since it is a broader organizational objective to have non-duplicative and non-competitive capabilities. With respect to actual RSDBU financial performance, it cannot be shown that ISO 9001:2000 certification has had a definitive effect on increasing funding or preventing the loss of funding.

As previously discussed, the primary financial incentive for achieving ISO 9001 certification for the RSDBU was to enable pursuit of FMS work. Since the RSDBU is not currently engaging in any FMS work, it cannot be demonstrated that funding has increased through this avenue. Similarly, none of the current RSDBU customers have formally made ISO 9000 certification a precondition for providing new tasking or preserving existing tasking, so it also cannot be shown that ISO 9000 has directly contributed to the expansion or preservation of the RSDBU business base. Therefore, the merits of the RSDBU quality management system must be determined as a subjective assessment as to whether ISO 9001:2000 provides benefit through improvement of internal processes that maximize value to the customer.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. WOULD ALTERNATIVE SYSTEMS WORK BETTER?

A. INTRODUCTION

This chapter discusses the advantages and disadvantages of alternate quality management systems and processes, and whether any of these alternate systems might be more appropriate for DoD research and development organizations.

B. ALTERNATE STANDARDS FOR R&D ORGANIZATIONS

Research and development, by its nature, is difficult to segment into consistent processes that can be measured and controlled. The processes involved with R&D are highly-coupled with the interim results (i.e., the 'product') of the R&D itself. The creation of new applications, technologies and ideas involves a significantly greater level of risk from a financial standpoint, since it is challenging to accurately predict the resources that will be required to achieve the next breakthrough, or even incremental improvement. Therefore, the selection of a quality management system for a research and development environment must reflect these realities and be suitable for wide variations in process outputs.

The disposition of the people that are generally employed in research and development environments is also often not conducive to the implementation or mandate of process conformance. Scientists and engineers who prefer the structure of scientific and engineering disciplines tend to be less than fond of processes outside those disciplines that interfere with the creative process by implementing boundaries of schedule or resources. It is questionable that Dr. J. Robert Oppenheimer would have been as effective, if the Manhattan Project had been ISO 9000 certified.

However, today's DoD research and development organizations do not operate under the same external imperatives as the Manhattan Project, which emphasized delivery speed above all else during wartime. The number of people involved in the DoD research and development process is also significantly greater, thereby, incurring a substantial financial resource requirement and commensurate need to operate efficiently and in a manner that maximizes value to the taxpayer. The current DoD environment can

be characterized as having efficiency in cost and schedule as the driving external imperatives, based on the ongoing economic and political climate of constrained budgets and increased military operations associated with the War on Terror.

Hence, the use of a quality management system within DoD research and development organizations serves to demonstrate a commitment by organizational leadership to achieve the current external imperative of efficiencies. The actual efficiencies achieved will be determined by the relevance of the implementation to organizational work processes and continuing senior management commitment to using, maintaining and improving the system implemented. The use of a commercially-developed standard further serves to support the objectives of acquisition reform and conversion to commercial standards begun by Secretary of Defense Perry in 1994. As previously stated, the selection of that standard should be based on the goals and operating environment of the organization.

As can be seen by the NASA example discussed in Chapter 3, ISO 9001 was initially selected as the best fit for that organization, but management policy was later modified to allow for greater flexibility at the discretion of organizational component management. This brings out another point: that the processes of an organization should be periodically revisited to ensure that they are in consonance with the current and projected operational environment. The continuance of a program simply because it exists has proven to be an unsound course of action in many past cases.

Based on the examples of quality management systems discussed previously, there is no specific system that is definitively more appropriate for a DoD research and development organization in comparison to ISO 9000. Other prevalent systems today, such as Six Sigma and CMMI, have evolved out of specific disciplines, and therefore, retain the focus of that area as their underlying process methodology, often limiting their utility in other applications. ISO 9000 underwent an analogous evolution from the manufacturing sector, beginning with the 1994 version and evolving to the 2000 version. The major difference of ISO 9000 as opposed to CMMI or Six Sigma is that it is

supported by a significant external standardization development body and has the benefit of a much larger audience of practitioners providing expanded views and inputs into the standards development process.

With the cancellation of the MIL-Q-9858 and MIL-I-45208 standards in 1995, the major DoD-driven quality standards were eliminated in favor of commercial standards. ISO 9001 was judged to be more comprehensive than MIL-Q-9858 as ISO 9002 (now obsolete and replaced by ISO 9001:2000) was deemed a suitable replacement for MIL-I-45208.[74] Although these standards were probably not initially written for internal government consumption, they could be considered as alternatives for establishing a quality management system.

The components of the ISO 9001:2000 standard have been generalized to the point that they should be broadly applicable to most organizations, providing enough of a framework to ensure a complete organizational analysis is conducted, but also being flexible enough to accommodate the peculiarities of individual organizations' requirements. In fact, the ISO organization refers to the ISO 9000 and ISO 14001 series of standards as "generic standards." "'Generic' also signifies that no matter what the organization's scope of activity, if it wants to establish a quality management system or an environmental management system, then such a system has a number of essential features for which the relevant standards of the ISO 9000 or ISO 14000 families provide the requirements."[75]

The aspect of international recognition of the ISO 9000 standards also provides an added benefit as DoD enterprises seek to leverage foreign government investments in defense technology to offset constrained research and development funding for military system procurement. The maturity of the ISO standard, combined with a robust

---

[74] Defense Supply Center Columbus, Defense Logistics Support Command, "ISO 9000 Quality System Standards, Application in DoD," http://www.dscc.dla.mil/library/quality_assurance/QAlibrary/dod_and_dla_quality_issues/iso_dlsc_iso_9000_presentation.ppt, Accessed May 22, 2004.

[75] International Organization for Standardization, "ISO 9000 and ISO 14000 - in brief," para 5, http://www.iso.ch/iso/en/iso9000-14000/index.html, Updated September 2003, Accessed May 22, 2004.

standards development and maintenance organization, suggests that it should be strongly considered by a DoD research and development organization seeking to implement a quality management system.

C. ALTERNATE QUALITY MANAGEMENT SYSTEMS

A wide array of organizational performance improvement tools are available today, and an even wider array of consultants are available to help organizational leadership in their implementation. Examples of organizational performance improvement tools include Balanced Scorecard, Benchmarking, Business Process Reengineering, Management by Objectives (MBO), Learning Organization, Knowledge Management, Strategic Planning, Six Sigma and Total Quality Management (TQM).[76] Each tool has a particular focus based on the objectives of the organization in the context of its current performance and the changes required to improve performance.

The duty of an organization's senior leadership is to select the appropriate tool to employ based on the desired changes in organizational performance. Tools such as Balanced Scorecard and Benchmarking emphasize measurement of organizational performance parameters, but typically operate in a reactive fashion since they only measure past performance. Business Process Reengineering aims at fundamentally changing an organization's processes and culture to achieve significant results and is usually employed in a context of a significant threat to organizational survival.

Quality management systems should be considered a subset of organizational performance improvement tools that focus on the quality of an organization's products and services as an indicator of organizational performance. From the RSDBU perspective, the decision to implement a quality management system was primarily driven by the desire to improve organizational financial performance, which made quality management, and specifically ISO 9000, a requirement. However, there was also a desire to standardize and document the processes of the organization, which most closely aligns with a quality management approach in comparison to other types of available tools.

---

[76] Carter McNamara, MBA, PhD, "Broad Overview of Various Programs and Movements to Improve Organizational Performance," Management Assistant Program for non-profits, Copyright 1999, http://www.mapnp.org/library/org_perf/methods.htm, Accessed May 22, 2004.

Accordingly, consideration in this analysis is given to a concurrent project management approach that was the previous organizational approach to performance improvement. Also considered is Total Quality Leadership (TQL) (the Navy implementation of TQM) at the strategic level based on the Navy's broad implementation in the 1990s. The Capability Maturity Model Integration (CMMI) was also considered during the RSDBU process development initiative, and therefore, warrants attention. Finally, the Six Sigma approach, which is an alternative commercial approach to quality improvement, merits discussion based on its increasing acceptance in aviation logistics organizations as an alternative to ISO 9001.

To evaluate the advantages and disadvantages of a given quality management approach for an organization, it is necessary to first examine the operating environment of the organization in question in terms of policy and incentives. In the case of the RSDBU, there is no current policy guidance on the use of a quality management system or quality standard internal to the government functions of the organization. While there is substantial guidance in the FAR and DFARS on the use of quality management in contracting, it does not apply to DoD internal operations. As further evidence, searches for policy directives and instructions through both NAVSEA and NUWC Division Newport publications resources reveal no policy guidance specifically related to quality management applicable to government components of the organization.

At the strategic level, the last significant steps taken toward formalizing a quality management culture within the government began in the first administration of President Clinton and were based on conclusions of the *National Performance Review* (NPR) program. During the same timeframe, the Department of Defense undertook its own complementary review process, the *Defense Performance Review* (DPR). "The DPR's objective [was] to devise innovative ways to encourage more businesslike practices and market-driven efficiencies throughout the department."[77] One of the twelve

[77] Government Documents Depart. University of Northern Texas, "Accompanying Report of the National Performance Review, Department of Defense: Part 1 of 2," 30 September 1993, http://govinfo.library.unt.edu/npr/library/nprrpt/annrpt/agnrpt93/dod1.html, Accessed May 22, 2004.

recommended actions from the DPR report issued in September 1993, was labeled "DOD08: Establish a Defense Quality Workplace."[78]

The Navy's implementation of this DoD quality initiative was the expansion of the TQL program from logistics elements to the entire service. Begun in 1984, TQL was based on "the leadership principles of Dr. W. Edwards Deming as the 'leverage' for a quality revolution within DOD"[79] The TQL initiative began with "a number of actions to ensure that ultimately TQM/TQL will become 'the normal way DOD accomplishes its mission.'"[80] The Navy established a Total Quality Leadership Office in the Washington, DC, area to provide products and services for consulting, education and training, information and communication, assessment, networking and liaison, and new technologies.[81] The TQL office was intended to be the service-wide resource to disseminate TQL principles for organizations to apply to their specific functions.

However, the Navy's TQL efforts never seemed to gain any significant traction and were dissolved in the late 1990's with no defined program in place as a successor. While broad guidance emphasizing quality remains at the DoD and Navy senior leadership levels, there is no specific implementation reaching down to the activity level. Government quality imperatives have continued to lack emphasis in the George W. Bush administration with the disestablishment of the Presidential Award for Quality in 2002. Established in 1988, this award was a modified version of the Baldrige Award, the national private-sector quality award named for the late Malcolm Baldrige, who served as Secretary of Commerce from 1981 to 1987.[82]

Therefore, in an undefined policy environment, the assessment of alternatives for a quality system implementation must be based on the operating environment and

---

78 Ibid.

79 Linda Doherty, Director, DON Total Quality, "TQL1303 -- DoD Formalizes Commitment To TQL/TQL," *The Department of The Navy's Total Quality, Leadership Newsletter*, Issue 13, March 1995, http://www.chinfo.navy.mil/navpalib/quality/tqleader/Tqleader.txt, Accessed May 22, 2004.

80 Ibid.

81 Joan Kraft, The Department of the Navy Benchmarking Handbook: A Systems View, Department of the Navy Headquarters, TQLO Publication Number 97-03, 28 May 1997, P.2, http://www.hq.navy.mil/RBA/bmkhnbk.pdf, Accessed May 22, 2004.

82 Stephen Barr, "Potent Symbol of Quality Management Headed for Chopping Block," *Washington Post*, 28 February 2001, P. B02, http://www.washingtonpost.com, Accessed May 28, 2004.

incentives of the individual organization. Beginning with the RSDBU example, it has been established that policy guidance is lacking and that the incentives of a NWCF organization place an emphasis on financial performance of the organization.

During the evaluation phase of the Code 70 process documentation initiative, other alternatives were considered as an augmentation to ISO 9001:2000, but the requirements of the FMS business base made achieving ISO 9001:2000 certification a priority in order to pursue international business opportunities.

Along with a lack of policy guidance, there was also an absence of historical reference. Previous organizational initiatives that most closely aligned with a quality management system had been focused on project management and systems engineering methodologies. These approaches primarily emphasized optimizing the technical design process, as opposed to documenting and improving overall organizational processes and their impacts on quality.

The most recent example of such an approach prior to the RSDBU ISO 9001:2000 certification initiative was based on the work of University of Rhode Island Professor Quentin C. Turtle. His book, titled *Implementing Concurrent Project Management*, is intended to provide a "complete procedure for implementing concurrent engineering in the planning, scheduling and controlling of technical projects."[83] Quality is addressed from a quality assurance perspective and emphasizes planning for optimization of quality assurance processes in the form of more rigor in estimating quality assurance requirements during the planning phase and a commensurate inspection protocol during design and production phases.[84]

The major difference in the Turtle approach compared to ISO 9000 is that Turtle is primarily focused at the product level, as opposed to the ISO 9000 perspective of quality at an organizational level. ISO 9000 uses a broader emphasis on the influence of external environmental factors, internal work processes, and measurement of customer satisfaction as indicators of quality in contrast to the Turtle approach of planning for

---

[83] Quentin Turtle, "Implementing Concurrent Project Management," PTR Prentice Hall, Englewood Cliffs, N.J., 1994, ISBN 0133020010, P. ix.

[84] Ibid., P. 8.

product measurement activities. In fact, the Turtle approach could likely be used as a methodology for establishing an ISO 9000 compliant design control process if its tenets were translated into the work instruction package, but would not satisfy the full spectrum of functions required for ISO 9000 certification.

The concurrent project management model emphasizes integration across major business functions, including marketing, finance, human resources, materials management, research and development, quality assurance, and manufacturing.[85] As such, its methodologies are constructed and sequenced to provide optimal value in a commercial product development setting where time to market and lowest cost are major driving factors. In this model, the time to market target is set at one year from design to production. Also, concurrent project management assumes that a single organization has cognizance over the entire life cycle, from design and development through production.

It is the authors' experience that the concurrent project management approach was generally inconsistent with the operations of the RSDBU. It contains several useful methodologies for project planning, such as cost estimation, functional specification development, and critical path definition. However, many of the other facets of this approach are geared to organizations that operate in a defined business area with specific products or product families whose requirements are driven by market forces.

Likewise, the assumption in the Turtle model of a single organization having control over the product lifecycle is also inconsistent with RSDBU operations, since most RSDBU products are single unit deliveries whose design and production are collaborative efforts amongst other industry partners and government activities. RSDBU members also have limited control over the human resources and finance portions of the Turtle model, further reducing its relevance.

Finally, the RSDBU business base does not correlate well to the concurrent project management approach due to the diversity of customer requirements, the extended time between similar projects and the small number of customers for RSDBU products. This results in generally unique products that have a long lifespan (20 years for

---

[85] Ibid., P. 7.

some components), which place an emphasis on quality and durability above the schedule drivers of the Turtle model in comparison to commercial products, which might be expected to more closely follow the Turtle model.

Another process approach that was considered during the RSDBU process documentation initiative was the use of the CMMI developed by the Software Engineering Institute (SEI) of Carnegie Mellon University. Although CMMI was initially conceived as a software development process tool, its approach is extensible to other product activities since, like ISO 9000, CMMI is focused on quality and process management. In fact, a version of CMMI called the CMMI Acquisition Module (CMMI-AM) has been developed for government acquisition organizations to "provide a foundation for acquisition process discipline and rigor that enables product and service development to be repeatedly executed with high levels of ultimate acquisition success."[86]

The documented version of the CMMI-AM process is relatively new in comparison to the RSDBU ISO 9000 certification effort, having been released in February 2004, three years after the RSDBU certification initiative. However, the concept of using a CMMI-based approach was part of the RSDBU consideration of alternatives, especially since software development is a significant portion of the RSDBU business base. The ISO 9001:2000 and CMMI models have been cross-referenced to provide a form of comparative analysis on the strengths and weaknesses of the two systems.[87]

The contrasts between the two approaches are primarily characterized by differing levels of focus on organizational elements. ISO 9000 is more focused on getting customer feedback and measuring satisfaction. While CMMI doesn't ignore customer satisfaction, it is not strongly emphasized either. ISO 9000 is much stronger on management buy-in *and* participation while CMMI is primarily focused on only initial management buy-in. ISO 9000 calls for clear internal and external communications plans while CMMI doesn't really address this from a management perspective.

---

[86] Tom Bernard (USAF ASC/EN), Brian Gallagher (SEI), Roger Bate (SEI), and Hal Wilson (Northrop Grumman), "CMMI® Acquisition Module (CMMI-AM)," Version 1.0, February 2004 [Technical Report, CMU/SEI-2004-TR-001, ESC-TR-2004-001] P. 7, http://www.sei.cmu.edu/pub/documents/04.reports/pdf/04tr001.pdf, Accessed May 28, 2004.

[87] Boris Mutafelija and Harvey Stromberg, July 2003.

Also, ISO 9000 is more consistent overall relative to control and oversight of purchasing tasks. CMMI covers purchasing tasks, but is considered weaker in this area. And while delivery and maintenance aspects of quality management are present in both ISO 9000 and CMMI, they are considered stronger in the ISO approach. Finally, another key difference between both the original CMMI and new CMMI-AM and ISO 9001:2000 is the emphasis on process documentation. CMMI and CMMI-AM do not provide a defined methodology for documentation of work processes and instructions, while ISO mandates process documentation as the most significant component of a quality management system. CMMI-AM is also focused on the execution of specific tasks at the project level as opposed to the broad organizational process approach of ISO 9001:2000.

There is one additional alternative system from the commercial world worth considering, which is the Six Sigma approach. Six Sigma was originally developed by Motorola in 1979, as a method to reduce manufacturing defects and the associated impacts on customer loyalty. "Users of the Six Sigma methodology have demonstrated that the surest way to improve performance is to systematically identify the causes of waste, lost productivity, and customer dissatisfaction, and then adjust internal processes to eliminate them."[88] It employs five steps for process optimization: define, measure, analyze, improve and control.

Much like ISO 9000, Six Sigma started in the manufacturing world and has since expanded beyond those boundaries. It has been applied to the banking industry,[89] electrical power distribution and even in a public school district.[90] Also, strikingly similar to ISO 9000 are the hordes of consultants springing up to provide services in implementing Six Sigma in most any organization. Within the Navy, Six Sigma

---

[88] Ali Kiran and Celal Kaplan, Contributors, "Six Sigma -- it's not just for manufacturers anymore," 29 March 2004, http://searchcio.techtarget.com/originalContent/0,289142,sid19_gci957154,00.html, Accessed May 28, 2004.

[89] Ibid.

[90] Mary Ruff, Six Sigma, "Using Six Sigma to Solve Issues in Public School System," 17 May 2004, http://www.isixsigma.com/library/content/c040517a.asp, Accessed May 30, 2004.

principles are being applied to naval aviation depots to reduce cycle time and improve efficiency,[91] including those same depots that have been certified to ISO 9001.

While Six Sigma provides a valuable framework to analyze processes, it is best applied to the improvement of repetitive processes that consistently perform the same activities and have large quantities of output products. In one user's opinion: "[i]t's best for organizations that produce lots and lots of small parts and want to get a 99.9% quality rate on the parts."[92] The examples cited above, such as naval aviation depots, banks, and public schools, all share the common trait of producing large volumes of output products with a desired high degree of conformity in the results. From the RSDBU perspective of mostly one-off system production, the Six Sigma approach would not likely be an effective alternative because of the difficulties of developing appropriate statistical methods applicable to a limited sample of diverse products. Furthermore, because the RSDBU completes mostly one-off system production, a business case analysis cannot be made for Six Sigma; as a result, Six Sigma is inappropriate for the RSDBU operating environment. As Mikel Harry and Richard Schroeder state in the third line of their book on Six Sigma process and application, "Six Sigma is about improving profitability [or, in the case of the government, cost reduction][93]

As revealed in the preceding examples, the selection of a quality management system should be based on the business base and operating methodologies of the organization. In fact, it may be more beneficial to consider an approach that supports business process optimization during the initial implementation of a quality management system, since the numerous systems available span many differing aspects of business process analysis. However, the key elements that can be seen throughout all of the preceding models are the need for organizational introspection and environmental analysis. Some, such as Six Sigma, tend to be more focused on internal process analysis, but the boundaries for that analysis and the measures of success will be determined by the

---

[91] Capt. Tim Trainer, "NAVAIR Airspeed Brief to Dod Maintenance Symposium & Exhibition," Brief, 5 September 2003, http://www.sae.org/events/dod/presentations/2003capttimtrainer.pdf, Accessed May 28, 2004.

[92] Richard Lutman, McLaughlin Research Corporation, e-mail, dated 17 May 2004.

[93] Harry Mikel J. and Richard Schroeder, Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, Doubleday, 2000.

external organizational environment. All of the models previously discussed essentially seek to drive an organization to align its internal processes with the external operating environment based on the policy and incentives of the organization.

There is no "one size fits all" solution for improving the performance of an organization; each system has advantages and disadvantages that must be weighed against organizational objectives. It is incumbent on senior management to identify the external imperatives of the organization's operating environment and select the appropriate tool to correlate the organization's outputs with those imperatives. External imperatives may be defined as quantity, cost, schedule, time to market, defect rate, or any number of other parameters or combinations of those parameters. An organizational performance improvement tool, such as a quality management system, should initially facilitate business process optimization and enable continuing improvement of those processes based on the priorities of customers and stakeholders. Furthermore, the system should be flexible enough to be tailored in such a way as to identify the tradeoffs amongst all facets of an organization's operations to maximize success.

For the senior management of the Engineering Test and Evaluation Department, ISO 9001:2000 represented the best choice for a quality management system for the RSDBU based on the applicability of the ISO 9001:2000 approach to the RSDBU business base and organizational imperatives. ISO 9001:2000 provided the flexibility to address the diversity of products developed by the RSDBU and enabled the integration of existing regulatory and policy requirements into the processes developed to achieve certification. Priorities of customers and stakeholders were accommodated in a manner that did not introduce a significant additional burden on teams executing programs. This allowed internal organizational priorities of management oversight and the support of the RSDBU core equity of undersea range development to be balanced against the external imperatives of efficiency and quality.

D. ISO AND STRUCTURED AND REGULATED ORGANIZATIONS

The generic approach of the ISO 9001 standard supports its use in an organization that is highly structured and regulated by accounting for existing regulatory and policy guidance as part of an organization's processes. Since one of the principal tenets of ISO

is process documentation, the established and well documented structure of the DoD acquisition process satisfies many of the ISO requirements. This allows a DoD organization pursuing certification to reference existing policy and regulations as process documentation without having to devote time and resources to the development of additional and unnecessary procedures.

While this aspect of ISO 9001 may facilitate certification, attempting to develop a common quality system for a large organization operating in a highly regulated environment would likely prove to be prohibitively complex and expensive. From the regulatory and policy perspective within DoD, there is the DFARS; annually changing congressional language; acquisition policy guidance of the DoD 5000 series of instructions; Chairman, Joint Chiefs of Staff instructions; and additional service-specific policy guidance and procedures. Attempting to correlate all of these inputs into a coherent set of ISO 9001:2000 process documentation would be a substantial task that has the potential to add yet another collection of documentation to an already saturated environment before even considering the significant expense of achieving and maintaining certification at a department or agency level.

Indeed, the argument has been made that ISO 9000 should be internalized in government service:

> It's not that those in government aren't aware of ISO 9000. They like it well enough to impose quality management systems based on ISO 9000 on their contractors. Regulatory agencies also think ISO 9000 is good enough to promote in their regulated industries… If those in government recognize that ISO 9000 is good for industry, why don't they believe it's good for government? Clearly, they need to rethink ISO 9000's possible applications in government and consider implementing it as their internal quality management system. ISO is as applicable to service providing organizations as it is to manufacturing organizations.[94]

While this argument has *prima facie* merit, it fails to consider the complexities of ISO 9000 implementation that have been demonstrated in the business world. The ISO 9000 implementation for Polyguard Products, a company with two dozen employees and

---

[94] Ira Epstein, "Raising Federal Standards," *Quality Digest*, July 1999, http://www.qualitydigest.com/july99/html/body_epstein.html, Accessed May 28, 2004.

$5M in annual sales, took $30,000 and one year in 1996.[95] Extrapolating those resource requirements to an agency the size of DoD leads to a financial obligation and schedule requirement that would invite unwanted congressional and media attention to an investment with an unquantifiable return.

Likewise, there is also an issue of public perception that all government activities must face. By virtue of being a taxpayer-funded organization, one of the prime external imperatives of government service is the demonstration of being a responsible steward of the taxpayer's money. For an organization such as NASA, their greater external imperative is the maintenance of America at the forefront of space travel and exploration, so the quality of their products in terms of safety and capability places financial accountability as a secondary external imperative. So from the NASA perspective, an organization-wide implementation of ISO 9001 could realistically be perceived and portrayed as a worthwhile investment in demonstrating a commitment to their foremost organizational imperative.

For DoD, a major criticism often received is a lack of efficiency. Former Vice President Gore's Hammer Award was a well-publicized symbol of inefficiencies and waste attributed to DoD procurement through the purchase of $435 hammers.[96] Therefore, a driving external imperative for DoD is efficiency in defense procurement, with quality being a close second. And since DOD is funded by Congress, whose primary function is financial oversight, DoD is most often reviewed in a financial perspective.

Based on the conclusion of Chapter 3 that a cost-benefit analysis for ISO 9000 implementation cannot be realistically done in either a predictive or comparative fashion for a government organization, it is unlikely that large organizational segments of DoD will reflexively embrace ISO 9000 given the primacy of the fiscal efficiency imperative. The implementation of a quality management system within this environment could be

---

[95] Margaret Allen, 15 August 1997.

[96] James Fairhall, "The Case for the $435 Hammer," University of Mississippi, http://home.olemiss.edu/~jmitchel/class/hammer.htm, [originally appearing in *The Washington Monthly*, January 1987], Accessed May 28, 2004.

perceived as yet another expenditure of taxpayer money without a quantifiable expectation of benefits, particularly at the broad level of the DoD mission. Attempting to launch a department-wide certification effort without an unequivocally quantifiable return on investment is unadvisable given the operating environment of DoD.

This assertion is borne out by the Navy's experience with TQL. Although the program began in 1984 as a performance improvement tool for Navy logistics organizations,[97] the attempt to deploy TQL across the Department of the Navy proved to be a substantial undertaking that met with limited success. From the logistics standpoint, naval aviation depots have moved on to ISO 9000 certification and are exploring the use of Six Sigma as their implementations of quality management. The quiet evaporation of the Navy TQL program in the late 1990s, leaving little behind as an organizational legacy, bears witness to the complexities of implementing a quality system at such a large scale.

The foregoing analysis and examples should not be viewed as a wholesale indictment of the use of ISO 9001:2000, or other appropriate quality systems, within a highly structured and regulated organization such as DoD. In the authors' opinion, ISO 9001:2000 has been an effective tool for the RSDBU for the documentation and improvement of internal business processes to make the RSDBU organization more efficient and responsive to sponsors and stakeholders. However, the level of the organization at which ISO 9001:2000 is targeted should be selected judiciously based on common organizational functions or business areas using a definable level of commonality that ensures the relevance of the quality management system to the employees who will be using it.

Therefore, the definable level of commonality must be established on a case-by-case basis for each organizational component considering the implementation of ISO 9001:2000. For the Engineering, Test and Evaluation Department, the parent organization of the RSDBU, the business units, of which the RSDBU is one, represented the best

---

[97] Archester Houston, Ph.D. and Steven L. Dockstader, Ph.D., "Total Quality Leadership: A Primer," Department of the Navy, Total Quality Leadership Office, TQLO Publication Number 97-02, P.5, http://www.balancedscorecard.org/files/primer.pdf, Accessed May 28, 2004.

level of organizational commonality for the development of an ISO 9001:2000 quality management system. This is driven by the fact the Engineering, Test and Evaluation Department is a fairly heterogeneous organization composed of many differing technical and engineering specialties serving numerous discrete business bases of NUWC Division Newport. For example, the Technology Applications and Development Division is composed of employees operating in three diverse specialties: undersea range systems development (supporting the RSDBU), reliability and system safety analysis, and physics-based modeling. It is unlikely that a highly effective common quality system could be developed that would be relevant to the organizational missions of these three groups.

The structure and regulatory environment of the RSDBU served to simplify the certification process by referencing existing documentation, where appropriate, to fulfill ISO 9001:2000 requirements. This efficiency can be replicated by other DoD organizations that wish to pursue certification as well. However, the overall effectiveness of the quality management system will be determined by the applicability of the developed processes to the organization's mission and operating environment. This requires that the scope of the organizational segments to be certified be carefully selected to maximize the relevance of the quality management system to employees' duties and thereby maximize the organizational improvements achieved.

V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The ISO 9000 quality management standards are internationally recognized as tools for the improvement of organizational performance. Within the United States Department of Defense acquisition community, the benefits of quality management standards have been recognized since the establishment of the MIL-Q-9858 quality management program in 1959. While quality management standards and programs have long been applied to contractors supplying DoD, there is no definitive guidance on the use of quality management standards *within* DoD.

The Defense Department maintains a large collection of research and development organizations that specialize in fields and disciplines critical to national defense, as well as organizations with numerous other functions. Those organizations primarily specializing in research and development focus on the specialized needs of the military where there is insufficient capacity in industry or the technologies are too specialized or sensitive for application to the commercial sector. Ultimately, the output of these organizations is translated into equipment, systems and services that are provided to the military to enable the execution of their assigned missions.

The application of an ISO 9000 quality management system within one such DoD activity, the Range Systems Development Business Unit (RSDBU) of the Engineering, Test and Evaluation Department of the Naval Undersea Warfare Center Division Newport has shown that the ISO 9001:2000 standard can be an effective organizational performance improvement tool for a DoD research and development activity. However, ISO 9001:2000 certification should not be considered a panacea for organizational performance or output problems; the attainment of certification is primarily a symbolic achievement that must have long-term management commitment to be a truly effective component of organizational performance improvement.

The RSDBU organizational imperatives of quality and cost-effectiveness are derived from the incentives of the NWCF organizational structure under which NUWC

Division Newport operates and the peculiarities of the business base for undersea range technology development. The NWCF is a revolving fund that relies on funded tasking from external customers rather than direct appropriations to finance its operations. As such, NUWC, and therefore the RSDBU, must generate sufficient revenue to cover the full costs of operations and finance continuing operations. Within these constraints, NUWC must operate on a break-even basis over time by neither making a profit nor incurring a loss. The business base of undersea tracking range system development has a customer base is limited to DoD and is characterized by diverse customers and requirements for highly specialized systems with highly aperiodic modernization, repair and replacement schedules.

B. CONCLUSIONS

ISO 9001:2000 represents one alternative in a broad collection of organizational performance improvement tools focused on quality. When choosing an organizational performance tool, the selection must be based on an organization's operating environment and incentives base to ensure that the implementation investment provides maximized benefit. For the RSDBU, the primary incentive base is the retention and expansion of the customer base by delivering quality products and services in a financially efficient manner.

The operating environment for the RSDBU continues to evolve in a manner that not only justifies the initial investment to achieve certification, but warrants continued investment in the maintenance and improvement of the RSDBU quality management system. Within this environment, the RSDBU implementation of ISO 9001:2000 has proven to be a sound investment in the establishment of a quality management system that helps to facilitate the achievement of organizational objectives in a cost effective manner. The original motivations for establishing documented processes were largely realized, and the operation and improvement of the system over the succeeding three years has demonstrated management commitment to the retention of ISO 9001:2000 certification.

As seen in the RSDBU program examples cited in Chapter II, the principal benefit of an ISO 9001:2000 quality management system has been the establishment of a

common set of management oversight processes and practices. As a research and development organization that operates across a relatively broad span of disciplines and customers, the application of a common program execution process based on ISO 9000 has established a consistent methodology for program performance monitoring which serves to set a baseline of expectation management for both employees and management.

While substantial tailoring for specific RSDBU program requirements is often necessary, the generalized approach of ISO 9001:2000 provides a more flexible framework than has been used in the past. Previous management monitoring approaches have generally been the imposition of mandated commercial program management tools that focus only on the technical design aspect of programs. However, these specialized systems tend to become less applicable, and, therefore, less efficiently useable over time as technical, regulatory and policy environments continue to evolve.

The RSDBU ISO 9001:2000 has demonstrated its utility in the execution of RSDBU programs and also revealed some areas for which it is not optimized, such as the execution of a development program in a highly dynamic external environment. The RSDBU system has also survived changes in senior management leadership since initial certification was achieved. The Code 70 Department Head position has been occupied by two successors who have remained committed to the Code 70 ISO quality management system. Changes have also been made in the Code 70 ISO Steering Committee membership, other senior leadership positions and the RSDBU team leader and member composition that have not significantly perturbed the overall execution of the process.

In part, the effectiveness of the RSDBU ISO 9001:2000 quality management system can be measured by surviving organizational evolution over time. Although three years are not necessarily a substantial period in some measures, the drive toward transformation in the national defense arena that has percolated down to the lowest levels of most, if not all, DoD organizations, has caused significant changes at NUWC Division Newport as the parent organization of the RSDBU.

Changes in environment, organization and management generally result in corresponding changes in business practices, sometimes with small realized gains. Perhaps

one of the additional side benefits of the ISO 9001 structure of third party registration and periodic accreditation is the level of visibility that would be associated with the loss of certification if that were to happen. As long as process standardization remains an imperative of the organization as a whole, an incentive is created to maintain an existing certification. From a working-level productivity perspective, once a process has stabilized to become understood and accepted, it is in the best interest of the organization to retain that process as long as it continues to provide some level of beneficial output.

The path to ISO 9000 certification of the RSDBU quality management system was relatively straightforward, although this is not the case for all organizations. The RSDBU implementation of ISO 9001:2000 has proven beneficial to the organization by providing a measurement and management tool that has been tailored to the overall focus of the RSDBU business base. By definition, the system cannot be optimized for every program and customer due to the diversity of the business base that drives the necessary generality of the quality management system. However, the initial investment in a quality management system can often be daunting for an organization depending on the scope of the processes involved, especially since it is difficult to specifically quantify the actual business performance gains achievable from the system.

The impact of a documented quality management system on the organizational output of a government enterprise will be difficult to reliably predict prior to making the investment due to the limitations of statistical process measurement for government functions. Accurately measuring the impact of a quality system on a government organization's performance metrics can be equally difficult once it has been established for this same reason. Gross measures may be derived based on "before and after" comparisons, but attributing detailed numerical quantities such as a reduction in operational costs or a decrease in cycle time to the predicted performance of a quality system would have a highly subjective interpretation.

ISO 9000 offers a defined methodology of process documentation that can be used for organizational performance improvement if applied correctly. However, ISO 9000 may initially be an expensive undertaking because of the scope of the effort involved in process documentation, and may be difficult to justify financially from a

return-on-investment perspective, unless a rigorous cost analysis system is already in place and functioning efficiently. If a cost-benefit justification is necessary, the business of the organization should also be such that "before and after" comparisons are realistic and based on consistently measurable quantities. Cost benefit analyses should also reflect that once the initial certification is achieved, resources must be devoted to maintaining and improving the quality system.

Therefore, ISO 9000 may not be a significantly better management tool than many of the other quality management schemas that are widely available, but ISO 9000 comes with the added benefit of international recognition that allows an organization to maximize its customer base. If a management team is truly motivated to improve organizational performance, ISO 9000 can be a valuable tool to assess the complete process. However, the final decision on a quality management system should be based on the compatibility of the tool to the organization's goals and operating methodologies, combined with the demands of the market in which the organization operates. If "market coercion" is a factor, that should be understood, but ISO 9000 will provide the most benefit if it is used as a tool to improve organizational performance, as opposed to a minimalist approach intended primarily to mollify customers.

As previously discussed, the primary financial incentive for achieving ISO 9001 certification for the RSDBU was to enable pursuit of FMS work. However, since the RSDBU is not currently engaging in any FMS work, it cannot be demonstrated that funding has increased through this avenue. Similarly, none of the current RSDBU customers have formally made ISO 9000 certification a precondition for providing new tasking or preserving existing tasking, so it also cannot be shown that ISO 9000 has directly contributed to the expansion or preservation of the RSDBU business base. Therefore, the merits of the RSDBU quality management system must be determined as a subjective assessment as to whether ISO 9001:2000 provides benefit through improvement of internal processes that maximize value to the customer.

For the RSDBU, ISO 9001:2000 represented the best choice for a quality management system based on the applicability of the ISO 9001:2000 approach to the RSDBU business base and organizational imperatives. ISO 9001:2000 provided the flexibility to

address the diversity of products developed by the RSDBU and enabled the integration of existing regulatory and policy requirements into the processes developed to achieve certification. Priorities of customers and stakeholders were accommodated in a manner that did not introduce a significant additional burden on teams executing programs. This allowed internal organizational priorities of management oversight and the support of the RSDBU core equity of undersea range development to be balanced against the external imperatives of efficiency and quality.

The aspect of international recognition of the ISO 9000 standards also provides an added benefit as DoD enterprises seek to leverage foreign government investments in defense technology to offset reduced research and development funding for military system procurement. The maturity of the ISO standard combined with a more robust standards development and maintenance organization supporting its evolution suggests that it is currently the best of the available alternatives for a DoD research and development organization.

The structure and regulatory environment of the RSDBU served to simplify the certification process by referencing existing documentation where appropriate to fulfill ISO 9001:2000 requirements. This efficiency can be replicated by other DoD organizations that wish to pursue certification as well. However, the overall effectiveness of the quality management system will be determined by the applicability of the developed processes to the organization's mission and operating environment. This requires that the scope of the organizational segments selected for certification be carefully analyzed to maximize the relevance of the quality management system to employees' duties; thereby, maximizing the organizational improvements achieved.

C. RECOMMENDATIONS

Following are the authors' recommendations derived from the results of this case study:

- Government organizations seeking ISO 9001:2000 certification should carefully quantify expectations for organization performance improvement with the understanding that benefits of certification cannot be strictly quantified in financial terms.

- All organizations, including government activities, choosing to pursue ISO 9001:2000 certification should use the initial process documentation effort, undertaken as part of the development of an ISO 9001:2000 compliant quality management system, as an opportunity to analyze and optimize business processes, as opposed to strictly documenting the existing way of doing business.
- Once an organization has adopted an ISO 9001:2000 quality management system, the continuous improvement process should include an assessment of the relevance of the ISO 9000 approach to the organization's existing and projected business base.
- For the RSDBU implementation, the minimum elapsed time between program reviews should be six months as opposed to the current one year. This will provide the opportunity for management to initiate any necessary corrective actions within the annual budget cycle.
- Third party certification of government ISO 9001:2000 quality management systems is important and should be required. Although DoD does not require third-party certification of contractors' quality systems, the authors believe that this is an important aspect to ensure that organizational management is motivated to maintain the system and retain its relevance to workforce activities.
- Implementation of an ISO 9001:2000 quality system within a DoD organization should be tailored to the organization's operating environment. Federal and DoD statutes, regulations and policy should be complementary to an ISO 9001:2000 quality system as opposed to adding another layer of bureaucracy.
- A DoD implementation of an ISO 9001:2000 quality system must be targeted at a manageable level for the organization to remain relevant. The greater the diversity of missions within the organizational unit to be certified, the greater the generalization of the QMS, which thereby reduces

the applicability to individual employees' and group's day-to-day functions.

- Navy Working Capital Fund activities that achieve ISO 9001:2000 certification, such as the RSDBU, should demonstrate the value of an ISO 9001:2000 QMS to customers and stakeholders.
- An ISO 9001:2000 quality management system should be used as part of a broader strategic management framework. An ISO 9000 QMS can fulfill the needs for an organizational performance evaluation methodology, but does not provide all of the necessary components for effective strategic planning.

D. RECOMMENDATIONS FOR FURTHER STUDY

An area for further study includes a detailed analysis of the application of ISO 9001 in larger organizations, such as NASA. A key focus should be the assessment of the point at which the effectiveness of ISO 9001 becomes reduced due to the broad scope of organizational processes encompassed by a single system. Corollary analyses could address the effectiveness of ISO 9001 in both commercial and government applications as a function of population of the certification community as well as the relative homogeneity or diversity of skill base qualifications found in those communities. Ideally, it should be possible to develop general guidance for an organization to optimize the implementation and operation of an ISO 9001 system using a set of metrics such as mission scope, population and skill mix to identify business and organizational segments that will recognize the greatest gains from a certified quality management system.

LIST OF REFERENCES

AD/Deputy Administrator. "ISO 9001 and Beyond" [letter]. to: Officials-in-Charge of Headquarters Offices Directors, NASA Centers. December 12, 2002. P. 1. http://www.hq.nasa.gov/iso/12_02_gregory.doc. Last accessed April 2004.

Allen, Margaret. "Polyguard Bolsters Quality, Productivity with ISO 9000 System Sysprocess." *Dallas Business Journal*. . From the August 15, 1997 print version [journal on-line]. P. 4. http://www.bizjournals.com/dallas/stories/1997/08/18/smallb1.html. Last accessed April 2004.

Alexander, Sonja. "NASA Achieves ISO 9001 Registration at All Sites." September 24, 1999. Available at http://articles.findarticles.com/p/articles/mi_pasa/is_/ai_366684083. Last accessed June 2004.

Ambrose, Mathew. "Past Performance in Supplier certification Programs: A Study of Current Certification and Incentive Practices in Certified Supplier Programs." ADA333461 (STINET). Corporate Author: Naval Postgraduate School Monterey CA. June 1997. http://stinet.dtic.mil/str/ Last accessed April 2004.

Barr, Stephen. "Potent Symbol of Quality Management Headed for Chopping Block." *Washington Post*, February 28, 2001. Page B02. http://www.washingtonpost.com. Last accessed March 2004.

Batalus Limited. "Implementing ISO 9000:2000, Choosing the Right Strategy," (Extracted from *The Audito*,. July 2001). http://www.batalas.co.uk/the-right-strategy.htm. Last accessed April 2004.

Bechtel. "The Way of Life for Doing Business at Bechtel." Bechtel Briefs. August 2003. http://www.bechtel.com/sixsigma.htm. Last accessed May 2004.

Bernard, Tom (USAF ASC/EN), Brian Gallagher (SEI), Roger Bate (SEI), and Hal Wilson (Northrop Grumman). "CMMI® Acquisition Module (CMMI-AM)." Version 1.0, February 2004. [Technical Report, CMU/SEI-2004-TR-001, ESC-TR-2004-001]. P. 7. http://www.sei.cmu.edu/pub/documents/04.reports/pdf/04tr001.pdf. Last accessed March 2004.

Brenneman, K. "How the Naval Aviation Maintenance Program (NAMP) at the Intermediate Level Can Become ISO 9000 Quality Management system compliant."ADA374354 (STINET). Corporate Author: Naval Postgraduate School Monterey, CA, December 1999. http://stinet.dtic.mil/str/. Last accessed April 2004.

Bonin, Richard L. . No title. e-mail to #NPRI_70. December 16, 2000.

Bray, Hollis G. Jr. "ISO 9000 in Construction." *Journal of Construction Education,* Vol. 2, No. 3 (Fall 1997). http://ascjournals.org/jce/journal/1997/no3/Fall%201997,%20Vol.%202,%20No.%203,%20pp.%20182-192.pdf. Last accessed March 2004.

BSI Management Systems. "Case Study List." http://emea.bsi-global.com/Quality/CaseStudies/CaseStudyList.xalter Last accessed April 2004.

The Business Link — Business Service Center. "What is ISO 9000?;" http://www.cbsc.org/alberta/tbl.cfm?fn=iso. Last updated March 11, 2003. Last accessed May 2004.

Cable, John H. and Gerald M. Westerback. "Assessment of ISO 9000Pilot Program." ADA 357423 (STINET). Corporate Author: Logistics Management Institute McLean, VA. November 1998. http://stinet.dtic.mil/str/. Last accessed April 2004.

The Center for Industrial Research and Service (CIRAS). Last updated September 16, 2002. CIRAS Copyright © 2002, Iowa State University. http://www.ciras.iastate.edu/toc/. Last accessed February 2004.

Carvalho, Doris. phonecon. April 15, 2004.

"The case against ISO 9000." Macpherson Publishing, Alexandra, New Zealand. Copyright 1999.

Chief of Naval Operations. Navy Commercial Activities (CA) Program. OPNAVINST 4860.7C, June 7, 1999. P. 1-24.

CIRAS Iowa State University Extension Service. "ISO 9000 Frequently Asked Questions." September 2002. http://www.ciras.iastate.edu/quality/ISO9000/info.asp. Last accessed February 2004.

Corbett, Charles J., María J. Montes, David A. Kirsch and María José Alvarez-Gil. "Does ISO 9000 Certification Pay." Management Systems, July-August 2000. http://www.worldpreferred.com/pub/IMS04-2002a31-40-LD.pdf Last accessed May 2004.

Couch, Christopher and Duane Decker. "Improving Naval Aviation Maintenance Quality Management Process at the Organization Maintenance Level: The Influences of the International Standard on (ISO) 9000Quality Management System on the Naval Aviation Maintenance Program (NAMP)." ADA 367296 (STINET). Corporate Author: Naval Postgraduate School Monterey, CA, June 1999. http://stinet.dtic.mil/str/. Last accessed April 2004.

Defense Supply Center Columbus, Defense Logistics Support Command. "ISO 9000 Quality System Standards, Application in DoD" http://www.dscc.dla.mil/library/quality_assurance/QAlibrary/dod_and_dla_quality_issues/iso_dlsc_iso_9000_presentation.ppt. Last accessed May 2004.

Department of the Navy. Application of the International Organization for Standardization (ISO) 9000 Series Quality Standards in NAVSEA Programs. NAVSEAINST 4855.33, 19 February 1997, P2.

Dick, Gavin P. M. "Certification Benefits, Reality or Myth?." *ISO 9000, The TQM Magazine*, Vol 12, Issue 6. ISSN 0954-478X. 2000. P. 2, 5.

DiverDiver, e-government@large. e-Government@large, 2004 Is The Year It All Goes Mainstream. September 24, 2002. http://www.diverdiver.com/2002_09_25_diverdiver_archive.html. Last accessed April 2004.

Doherty,Linda Director, DON Total Quality. "TQL1303 -- DoD Formalizes Commitment TO TQL/TQL." *The Department of The Navy's Total Quality, Leadership Newsletter*, TQL1303, Issue 13, March 1995. http://www.chinfo.navy.mil/navpalib/quality/tqleader/Tqleader.txt. Last accessed May 2004.

Epstein, Ira. "Raising Federal Standards." *Quality Digest*, July 1999. http://www.qualitydigest.com/july99/html/body_epstein.html. Last accessed May 2004.

Fairhall, James. "The Case for the $435 Hammer." University of Mississippi. [originally appearing in *The Washington Monthly*, January 1987]. http://home.olemiss.edu/~jmitchel/class/hammer.htm. Last accessed May 2004.

Fetzer, Daniel T. "Making Investment Decisions for Software Process Improvement." *Software Tech News*, Volume 5, No. 4, November 2002. http://www.softwaretechnews.com/stn5-4/investment.html. Last accessed May 2004.

FitzGibbon,. Chris, MMS, CQA, CSQE, CQMgr. "Are Companies Earning Return on Their Investment in ISO 9000 Registration? A Review of the Empirical Evidence." Orion Canada, Inc., 2000. http://www.orioncanada.com/Rev-art.htm. Last accessed April 2004.

Garver, Roger."Are There Benefits to ISO 9000 Registration? More Importantly, does Superior Service Matter?" Distribution Solutions, Inc., 1997. http://www.distribution-solutions.com/newpage7.htm. Last accessed April 2004.

General Accounting Office, Washington D.C. National Security and International Affairs Division. "Best Practices: Commercial Quality Assurance Practices Offer Improvement for DoD."ADA 313504 (STINET). August 26, 1996. http://stinet.dtic.mil/str/. Last accessed May 2004.

Government Documents Depart. University of Northern Texas. "Accompanying Report of the National Performance Review, Department of Defense: Part 1 of 2." September 30, 1993. http://govinfo.library.unt.edu/npr/library/nprrpt/annrpt/agnrpt93/dod1.html. Last accessed May 2004.

Gray, James A. "A Cost of Quality analysis of the Repair Division Marine Corps Logistics Base, Albany, GA."ADA292075 (STINET). Corporate Author: Naval Postgraduate School Monterey, CA, December 1994. http://stinet.dtic.mil/str/. Last accessed April 2004.

Greenhalgh, Debra J. "AMSWR ISO PDR Review Updates (Comments)." email to Doris M. Carvalho, August 5, 2003.

Gregory, Frederick D., Associate Administrator for Safety and Mission Assurance [signatory]; NASA Headquarters. "Program Commitment Agreement, NASA Registration to the United States Version of the International Organization for Standardization's 9000 Series Standard." July 9, 1999. http://www.hq.nasa.gov/office/codeq/doctree/isopca.pdf. Last accessed April 2004.

Harry, Mikel J. and Richard Schroeder. Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations. Doubleday, 2000.

Houston, Archester, Ph.D. and Steven L. Dockstader, Ph.D. "Total Quality Leadership: A Primer." Department of the Navy, Total Quality Leadership Office. TQLO Publication Number 97-02. P.5. http://www.balancedscorecard.org/files/primer.pdf. Last accessed May 2004.

ISO International Organization for Standardization Home Page. www.iso.ch . Last accessed June 2004.

International Organization for Standardization. "About ISO - Introduction." http://www.iso.ch/iso/en/aboutiso/introduction/index.html. Last modified February 16, 2004. Last accessed June 2004.

Ibid.,. "ISO 9000 and ISO 14000 - in brief." para 5. http://www.iso.ch/iso/en/iso9000-14000/index.html. Latest update September 2003. Last accessed June 2004.

Ibid., "Statistics on certifications worldwide;" 1st para. http://www.iso.ch/iso/en/xsite/contact/01enquiryservice/011ISO9000/certification/stats.html. Last modified March 8, 2004. Last accessed May 2004

Janiesch, Robert E. "Coordinating Systems Engineering, ISO 9001 and CMM to Code 70 Programs." presentation to Team Leaders, March 26, 2001. Slides 3-4.

Ibid., "ISO 9001:2000 Rollout for the Range Systems Development BU." presentation, June 8, 2001. Slide 5.

Kiran, Ali and Celal Kaplan, Contributors. "Six Sigma—It's Not Just for Manufacturers Anymore." 29 March 2004. SearchCIO website at http://searchcio.techtarget.com/originalContent/0,289142,sid19_gci957154,00.html. Last accessed April 2004.

Kozios, John C. "How to Prepare for a Quality Air Force Assessment - A Commander's Guide." ADA328779 (STINET). Corporate Author: Air War College Maxwell AFB AL, February 24 1995. http://stinet.dtic.mil/str/. Last accessed April 2004.

Kraft, Joan. The Department of the Navy Benchmarking Handbook: A Systems View. Department of the Navy Headquarters. TQLO Publication Number 97-03, May 28, 1997. http://www.hq.navy.mil/RBA/bmkhnbk.pdf. Last accessed May 2004.

Lucius. J. "Department of Defense Quality Management system and ISO 9000:2000." ADA 402741 (STINET). Corporate Author: Naval Postgraduate School Monterey, CA, March 2002. http://stinet.dtic.mil/str/. Last accessed April 2004.

Lutman, Richard .BSI case studies summary. McLaughlin Research Corporation.

Lutman, Richard. e-mail. dated May 17, 2004. McLaughlin Research Corporation.

McNamara, Carter, MBA, PhD. "Broad Overview of Various Programs and Movements to Improve Organizational Performance." Management Assistant Program for non-profits, Copyright 1999. http://www.mapnp.org/library/org_perf/methods.htm. Last accessed April 2004.

Mutafelija, Boris and Harvey Stromberg. "ISO 9001:2000 -- CMMI v1.1 Mappings." Carnegie Mellon Software Engineering Institute, July 2003. http://www.sei.cmu.edu/cmmi/adoption/iso-mapping.pdf. Last accessed May 2004.

NASA Quality Management Systems. "Welcome to the Agency Quality Management System Page!" para. 1. http://www.hq.nasa.gov/iso/. Last accessed May 2004.

NASA. "ISO 9001 Part of the Big Picture." *Spaceport News*, July 18 1997,Volume 36, Number 14. http://www-pao.ksc.nasa.gov/kscpao/snews/1997/jul/jul18-4.htm#iso Last accessed May 2004.

Naval Postgraduate School of Business and Public Policy, Course material from MN3155, Financial Management for Acquisition Managers. Winter Qtr 2000. PP. 20-30.

NAVSEA. "NAVSEA Command Performance Inspection (CPI) Team 6 Improvements." September 21, 1999.

Navy Office of Information. "Top Five Priorities." http://www.chinfo.navy.mil/navpalib/cno/cno-top5.html Last accessed May 2004.

NUWCDIVNPT, NUWC Concept of Operations (CONOPS). 25 January 2004. PP. 1, 2, 30.

NUWCDIVNPT, Code 70. "ISO 9001:2000 Management Review, Range Systems Development Business Unit Review Meeting." presentation briefing, March 16, 2004. PP. 3-6.

NUWCDIVNPT, Intranet. "Keeping America's Navy #1 in the World." Mission Statement, Last update June 18, 2004.

NUWCDIVNPT, Engineering, Test, and Evaluation Department. Code 70 Concept of Operations. Revision 5C, January 2003, Section 10.0 and Appendix B.

NUWDIVNPT, Code 70. Customer survey data FY02 summary, compiled and retained within Code 70

NUWCDIVNPT. Code 70 Departmental Business Unit and Cost Center Quality Processes Manual. (Level I Document). May 3, 2004. P. 24.

NUWCDIVNPT, Code 70. Ranges, Engineering and Analysis Department (Code 70) Range Systems Development Business Unit, Design Control. Doc. No. RSD-QMP-73-01, Rev. 3, February 24, 2004. PP. 1, 17, 74.

NUWCDIVNPT, Code 70. Task Review Work Instruction. Doc. No. RSD-QMP-72-02, Rev. 4, November 17, 2004. PP. 2-3 .

NUWCDIVNPT, Code 70. Information resides on Code 70 ISO Folder located on global drive (\\Npri70fs\global\ISO\Review Minutes\Task Reviews)

NUWCDIVNPT, Code 70. Program Review Process Work Instruction. Doc. No. RSD-WI-DES-01, Rev. 3, October 20, 2003. P. 1.

NUWCDIVNPT, Code 70. "Training, Test and Evaluation Department, Code 70, Department Brief." Overview presentation, June 10, 1999.

NUWCDIVNPT. "Code 70 Range Systems Development Business Unit Technical Approach/Program Plan Review Meeting Minutes." August 12, 2002.

NUWCDIVNPT, AMSWR Team, Code 70. "AUTEC Minefield & Shallow Water Range (Berry Island Range)." Presentation, July 17, 2003. P. 42.

NUWCDIVNPT, Code 70. "ISO 9001:2000 Management Review, Range Systems Development Business Unit Review Meeting." Presentation briefing, March 26, 2004.

NUWCDIVNPT, Code 70. Customer Feedback and Complaints. Doc. No. DBU-QMP-72-01, Rev. 0, March 23, 2004. P. 3.

NUWCDIVNPT, Code 70. "ISO 9001:2000 Management Review, Range Systems Development Business Unit Review Meeting." Presentation briefing, March 26, 2004. P. 13.

NUWCDIVNPT, Code 70. Summary of Range Systems Development Business Unit (RSDBU), Department Business Unit And Cost Center(s) (DBU) Level II Document. June 2, 2004. P. 1.

NUWCDIVNPT. Procedures for Obtaining Level 1 Material Certification. DIVNPTINST 4410.2F, 22 July 2002.

NUWCDIVNPT. Code 70 financial data and AUTEC I&M program status briefs derived from multiple internal sources.

NAVSEA, Carderock Division. "November 1998 Excerpt: Division Recertified to ISO 9001." *WAVELENGTHS* (Newletter), November 1998. http://www.dt.navy.mil/pao/excerpts%20pages/1998/isonov.html Last accessed April 2004.

Ibid. "ISO Recovery Plan A Success." September 1998.

The Navy Public Affairs Library. "TQL301 – "TQL just makes good sense," says O'Keefe."*The Department of the Navy's Total Quality Leadership (TQL) Newsletter*, Vol. 1, Issue 3, September 1992. http://www.chinfo.navy.mil/navpalib/quality/tqleader/tqlv1i03.txt. Last accessed May 2004.

Ibid. "TQL302 - Benefits of Strategic Planning."

Ibid. "TQL305 - Case Study: Naval Aviation Supply Office, Philadelphia."

Ibid. "TQL309 - The Only Way Ahead."

Ibid. "TQL313 - Putting TQL to Work at Marine Corps Headquarters."

Ibid. “TQL317 - What is "It"?”

Ibid. “TQL318 - Fleet-wide TQL Implementation Plan Announced”

Ibid. “TQL319 - Senior Leaders Seminar Update.”

Ibid. “TQL101 - Secretary of the Navy H. Lawrence Garrett III Speaks Out on the Need for Change.” Vol. 1, Issue 1, September 8, 1994. http://www.chinfo.navy.mil/navpalib/quality/tqleader/tqlv1i01.txt Last accessed May 2004.

Ibid. “TQL105 - Guiding Principles for the Support Establishment of the DON.”

Ibid. “TQL106 - Commandant's Corner: Change in the Marine Corps.”

Ibid. “TQL107 - CNO Says: Improving with Quality.”

Ibid. “TQL108 - Under Secretary Howard Answers Your Questions on TQL.”

Ibid. “TQL109 - Case Study: Naval Aviation Depot Norfolk.”

Ibid. “TQL110 - Senior Leaders Seminar.”

Ibid. “TQL111 - Abstract: "The Journey From Bureaucracy to TQM".”

Ibid., “TQL1102 - NAVAIR Receives Presidential Award for Quality.” Vol. 2, Issue 11, September 1994. http://www.chinfo.navy.mil/navpalib/quality/tqleader/tqlv2i11.txt Last accessed May 2004.

Ibid. “TQL1105 - NUWC Keyport Wins Quality Improvement Prototype Award.”

Ibid. “TQL1108 - Thinking About Thinking About Quality.”

Ibid., “TQL201 - Vice Admiral John H. Fetterman Jr. on the Department's TQL Education and Training Plan.” Vol. 1, Issue 2, October 3, 1994. http://www.chinfo.navy.mil/navpalib/quality/ tqleader/tqlv1i02.txt. Last accessed May 2004.

Ibid. “TQL203 - CNO Says:”

Ibid. “TQL204 – Commandant's Corner:”

Ibid. “TQL205 - Under Secretary Howard Answers Your Questions on TQL.”

Ibid. “TQL206 - History in the Making.”

Ibid. “TQL207 - Department of the Navy Strategic Goals.”

Ibid. “TQL208 - Top Leaders Gather for Deming Seminar.”

Ibid. “TQL209 - Senior Leaders Seminar Update.”

Ibid., “TQL1202 - From Zero to Quality in 18 Months.” Vol. 1, Issue 12, January 1995. http://www.chinfo.navy.mil/navpalib/quality/tqleader/tqlv2i12.txt. Last accessed May 2004.

Ibid. “TQL1203 - People ask me about TQL . . ."

Ibid. “TQL1208 - A Better Way: the USS ENTERPRISE.”

OSD Comptroller iCenter. “A Little Background.” http://www.dod.mil/comptroller/icenter/dwcf/background.htm

Paquette, Dale L.. “Lead Engineer SITREP.” e-mail to: #NPRI_70, 25 February 2000.

Paulk, Mark L. “A Comparison of ISO 9001 and CMM for Software.” ADA290697 (STINET). Corporate Author: Carnegie Melon University Pittsburgh Software Engineering Unit, August 1994. http://stinet.dtic.mil/str/. Last accessed April 2004.

Quality Digest, ISO 9000 Database. http://www.qualitydigest.com/iso9000database.shtml. Last accessed May 2004.

Reid Robert J; “RE: History Question.” e-mail to Appleget Andrew. 29 March 2004.

Reid, Robert J. “AUTEC Shallow Water Range & Minefield (ASWRM) - ISO 9001 Requirements & Technical Approach Review.” Presentation briefing, August 12, 2002. PP.12-13.

Rice, Gary. “NNS030113-04 - ISO Audit Helps Depot Improve and Excel.” *Navy News*, January 14, 2003. http://www.news.navy.mil/search/display.asp?story_id=5287. Last accessed May 2004.

Rich, Nick. “An Executive Guide to Lean Thinking.” Deloitte & Touche Senior Executive Series of Briefing Papers; [Deloitte & Touche Senior Research Fellow Lean Organisation Research Centre, Cardiff Business School]. http://www.deloitte.com/dtt/cda/doc/content/lean_briefing(1)(1).pdf. Last accessed April 2004.

Ruff, Mary, Six Sigma. “Using Six Sigma to Solve Issues in Public School System.” May 17, 2004. http://www.isixsigma.com/library/content/c040517a.asp. Last accessed April 2004.

Seddon, John. The Case Against ISO. Second edition, Oak Tree Press, November 2000.

Seddon, John. “ISO 9000 implementation and value-added: Three case studies.” From: Welcome to the Elsmar Cove! ISO 9000 - QS-9000 Information Exchange (website), April 1996. http://elsmar.com/iso/iso9000_cases.html. Last accessed April 2004.

Stoddard, C.W. “ISO 9000 effect on Global Marketplace and Contract Relations with US Department of Defense.” ADA 359914 (STINET). Naval Postgraduate School Monterey, CA, December 1998. http://stinet.dtic.mil/str/. Last accessed April 2004.

Stone, Mike. “A Survey of SMEs and Their Attitudes Towards the Implementation of ISO 9001:2000.” Saferpak Ltd. http://www.saferpak.com/iso_art2.htm. Last accessed April 2004.

Thakkar, Ashok. M. .“The Rise And Fall Of ISO 9001?.” *Quality Digest*, September 2003. http://www.qualitydigest.com/sept03/articles/03_article.shtml. Last accessed May 2004.

Trainer, Tim Capt. "NAVAIR Airspeed Brief to Dod Maintenance Symposium & Exhibition." Presentation, September 5, 2003. http://www.sae.org/events/dod/presentations/2003capttimtrainer.pdf. Last accessed April 2004.

Turtle, Quentin. Implementing Concurrent Project Management. PTR Prentice Hall, Englewood Cliffs, N.J., 1994. ISBN 0133020010. P. ix, 7, 8.

U.S. Department of Labor, Standard Industrial Classification (SIC) System Search. http://www.osha.gov/pls/imis/sicsearch.html. Last accessed May 2004.

Vanguard Educational Website. http://www.lean-service.com/sub2.asp. Last updated November 10, 2003 Last accessed May 2004.

"The Vanguard Standards: A systems thinkers guide to interpretation and use of ISO 9000:2000." http://www.lean-service.com/3-1.asp. P.2. Last accessed May 2004.

Weber, Cynthia. "Benefits of ISO 9000…." Quest Analytical, Inc. presentation, March 15, 2004. http://www.the9000store.com/benefits_of_iso.ppt. Last accessed May 2004.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Fort Belvoir, VA

2. Dudley Knox Library
   Monterey, CA

3. Larry W. Rothstein
   Naval Undersea Warfare Center, Division Newport
   Newport, RI

4. Andrew T. Appleget, Naval Undersea Warfare Center, Division Newport
   Newport, RI

5. Wilfred M. Canto, Naval Undersea Warfare Center, Division Newport
   Newport, RI

6. Professor Michael W. Boudreau
   Naval Postgraduate School, Code GB/Bm
   Monterey, CA

7. Dr. Raymond S. Munn
   Groton, CT

8. Doris M. Carvalho, Naval Undersea Warfare Center, Division Newport
   Newport, RI